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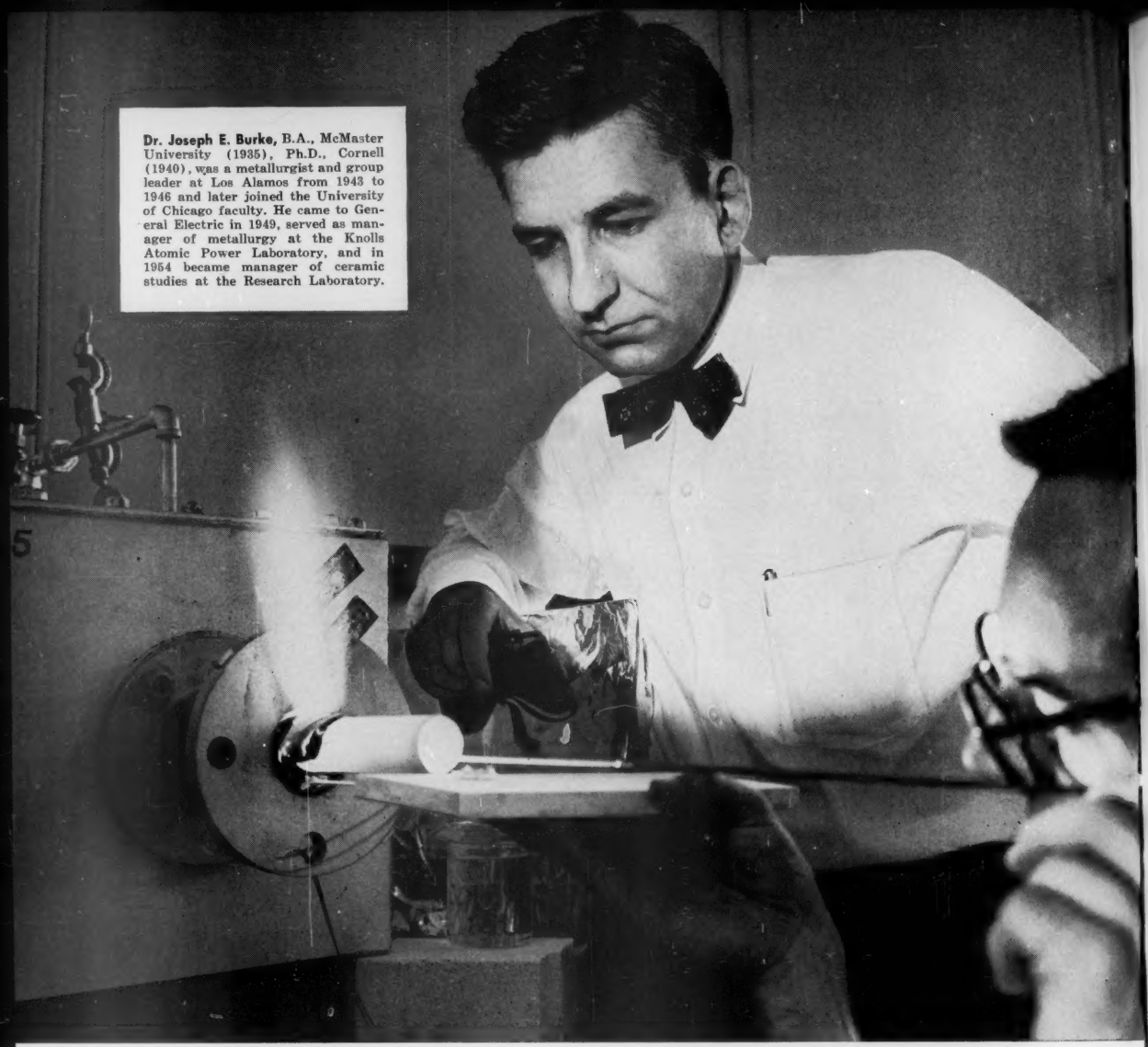

Dr. Joseph E. Burke, B.A., McMaster University (1935), Ph.D., Cornell (1940), was a metallurgist and group leader at Los Alamos from 1943 to 1946 and later joined the University of Chicago faculty. He came to General Electric in 1949, served as manager of metallurgy at the Knolls Atomic Power Laboratory, and in 1954 became manager of ceramic studies at the Research Laboratory.

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In Defense of the Nation

On pages 210–212 we reprint the recommendations of the Special Committee on the Federal Loyalty-Security Program of the Association of the Bar of the City of New York. The authors of this report have kept clearly in focus the central issue of the whole security problem. This problem is not to defend scholars, foreign visitors, or any other special group. Neither is it, fundamentally, to attack communistic or other subversive influence. The real problem is to safeguard the nation, all of it, its military and industrial strength and the ideals and traditions on which it has grown great. The report is a thoughtful, tempered analysis of the communist threat to the free world, of the achievements and the costs of the federal loyalty-security program, and of the changes recommended by the committee to improve that program. The report is a welcome addition to the literature on the security problem, both for what it says and, even more, for who said it.

Defects in the underlying philosophy and in the administrative practices of our several loyalty-security systems have been pointed out repeatedly since the inception of these programs. In many instances, the recommendations of the bar association parallel earlier recommendations by other groups. Many of the earlier reports—for example, those written by scientists—came from groups that were directly affected by the programs they were criticizing. Because science has become increasingly closely linked with military strength, and because science is more international than are most other pursuits, scientists, more than most groups, have been directly affected by loyalty and security programs. Consequently when scientists have criticized existing policies and practices, it has been easy to accuse them of special pleading.

The bar association is not open to this accusation. Members of the bar have had primary responsibility for the development of our body of law and the administrative procedures under which the laws are applied. In the field of public policy, the legal profession enjoys high prestige. With minor exceptions, the bar has escaped the charge of communist infiltration that could be used as an excuse for charging its recommendations with bias. Thus this report will undoubtedly seem persuasive to readers who would discount the same recommendations from many another source.

The timing is also fortunate. After the report was completed but before it was published, the Supreme Court ruled that the intent of Congress in establishing the federal security program was to restrict its provisions to sensitive areas and not to blanket the entire Civil Service.

A few persons, both in Congress and in the Executive branch of the Government, reacted to the Supreme Court decision by recommending passage of a new law that would classify all federal positions as involving national security. Such haste is more political than necessary, for, as the Supreme Court pointed out, there remains ample authority to dismiss employees on loyalty grounds and to handle security problems. We can, therefore, more advisedly let new legislation wait until after members of Congress have had an opportunity to consider the bar association report and the report of the Commission on Government Security that Congress established last year. If that report follows the impartial pattern of the bar association study, it too—and for similar reasons—will be a powerful influence in clarifying our present badly muddled set of security systems and regulations.—D. W.

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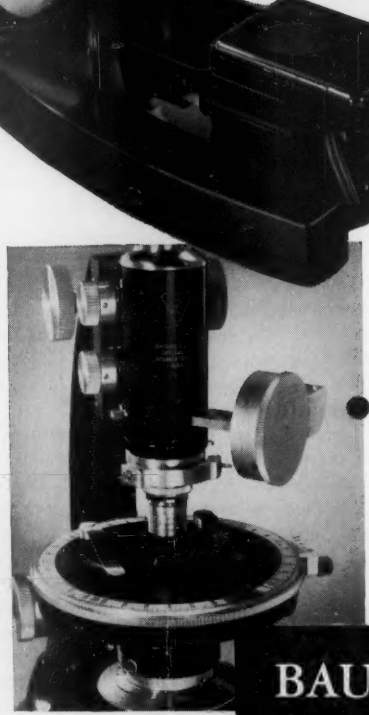

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On the Mitotic Movements of Chromosomes

J. Gordon Carlson

It is my purpose to bring together some of the published and unpublished results that my coworkers, students, and I have obtained in recent years in studying mitosis and the effects of certain physical, chemical, and mechanical treatments on it. Anyone who has watched mitosis in the living cell cannot fail to have asked himself what causes the regular, precise succession of nuclear and cytosomic changes associated with division. Ever since the main morphological features of mitosis were observed in the 1870's, cytologists and cellular physiologists have speculated about the nature of the forces responsible for the various phases of chromosome orientation and movement in the dividing cell. The universality of mitosis in the plant and animal kingdoms, its preciseness in distributing through countless cell generations exact halves of each chromosome to each of the many kinds of cells that comprise the organism, and the amazing similarity in the process even in the most diverse kinds of cells suggest that, in an evolutionary sense, very basic phenomena are involved. A mass nuclear division called amitosis is known to occur in some organisms, but it is certainly rare. Mitosis is, indeed, almost as universal a phenomenon of nuclear reproduction as the cell is a unit of organismal structure.

A critical review by Schrader of the literature on the movements of the chromosomes in cell division has appeared recently (*1*); therefore, I have limited my remarks to certain aspects of this problem on which our recent studies of grasshopper neuroblasts have a bearing. Neuroblasts are large cells that exist temporarily on either side of the midventral line of the embryo early in development. They occur on or close to the surface and lay down by successive divisions smaller ganglion cells that differentiate to form the cells of the ventral nerve cord. Their large size and location at the surface make it possible to observe mitosis in great detail in hanging-drop culture preparations. The results we have obtained with the neuroblast probably hold for many, but not all, kinds of cells. The grasshopper we have used is *Chortophaga viridifasciata* (De Geer).

The author is professor of zoology at the University of Tennessee. This article is based on the vice-presidential address given before Section F–Zoological Sciences at the Atlanta meeting of the AAAS.

Telophase-Interphase-Prophase Orientation

A striking feature of many cells, and in particular of the grasshopper neuroblasts, is the close resemblance between the chromosome orientation at telophase (Fig. 1) and at the succeeding late prophase (Fig. 2). In each, the spindle attachment ends, or centromeres, of the chromosomes are clustered in a group close to or against the nuclear membrane, and the distal ends radiate outward and toward the sister cell. In the intervening stages, however, the long, twisted chromatin threads appear to have no orderly arrangement within the nucleus. One means of accounting for similarly oriented chromosomes separated by a stage of apparent disorder is to assume that the chromosomes are not free within the nucleus, but are attached in a limited region of the nucleus from the time it arises in telophase until it disappears at the end of prophase. The logical points of attachment would be the centromeres of the chromosomes. There is experimental evidence from microdissection, radiation, and colchicine studies that the chromosome centromeres have a regular, fixed orientation within the nucleus.

If a microneedle is inserted in the nucleus of a neuroblast in late prophase and moved crosswise to the chromosomes, their distal ends can be displaced more readily than their proximal ends, which behave as if they are fastened in a group at or near the nuclear membrane.

Certain kinds of chromosome translocations induced in interphase or prophase by ionizing radiations are manifest in the succeeding metaphase as chromosomal elements with two centromeres each, known as dicentrics. It happens rarely, if ever, that these two centromeres are adjacent to each other on the metaphase spindle of the neuroblast. Nearly always, one or more chromosomes intervene, and these together with the including dicentric are often crowded quite closely together as compared with the others, which are more widely spaced than usual on the periphery of the spindle. This suggests that the position of the centromeres with respect to each other is fixed by attachment to some part of the nucleus or the inner surface of the nuclear membrane early in prophase at the time when the translocation was induced and before the late-prophase shortening of the chromosome has occurred, and that this attachment is sufficiently strong to be maintained into metaphase, even at the expense of crowding the intervening centromeres.

X-ray-induced chromosome breakage in *Tradescantia* microspores has been found by Sax and Mather (*2*) to occur with greater frequency at the centromeric than at the distal ends of the chromosomes. The breakage frequency was also greater in chromosomes with centromeres than in acentric fragments, which lack centromeres (*3*). These effects are interpreted as demonstrating greater torsional stresses near the centromere, which in turn implies that the maintenance of chromosome polarity during interphase and early prophase is due to some intranuclear attachment of the centromere.

Occasionally neuroblasts that are exposed to colchicine in late prophase are blocked at this stage for several hours.

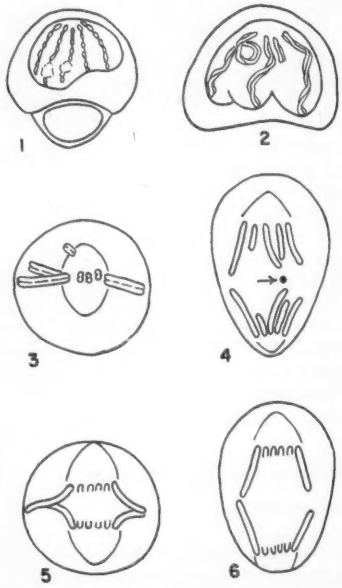
In such cells the chromosomes lose their telophaselike orientation inside the nucleus and come to lie at random with respect to one another (*4*). Since colchicine-induced destruction of the metaphase spindle results in a similar disorientation of chromosomes through loss of centromere attachments at a stage when chromosomes and spindle have replaced the nucleus, it is logical to suspect that the disorientation within the prophase nucleus has also resulted from destruction of a spindle or spindlelike material to which the centromeres are normally attached.

Metaphase Orientation

The metaphase arrangement of the chromosomes to form an equatorial plate raises certain interesting questions involving the relation of metaphase to earlier and later stages. If neuroblasts in very late prophase or prometaphase are treated with a relatively large dose of ultraviolet radiation of wavelength 2250 angstroms, normal development of the spindle is temporarily prevented (*5*). After the breakdown of the nuclear membrane, part of the clear material of the nucleus, instead of accumulating centrally to form a spindle, flows to one side of the cell to form a large clear globule. The remainder maintains contact with the chromosomes as an abnormally small and often irregularly shaped presumptive spindle, to which the chromosome centromeres are attached in a compact group, and from which the chromosomes extend outward in all directions. Often one or more of these chromosomes moves temporarily away from the others, but retains contact at its centromere with the spindle substance (Fig. 3). With the eventual organization of this material into a definitive but small spindle, such chromosomes slowly move toward and finally rejoin the main group, which, meanwhile, has formed an equatorial plate. By watching this movement, one can predict exactly when anaphase will begin, for it never starts until all the chromosomes are in the equatorial plate, and it always starts as soon as the last one has reached it.

M. E. Gaulden and I (*4*) have found a similar effect after prolonged treatment of neuroblasts with very low concentrations of colchicine, which, like short-wavelength ultraviolet, interferes with spindle formation. The colchicine concentration and duration of treatment are quite critical in the induction of this effect. In the neuroblast, interference is produced 3 to 4 hours after the cells are placed in a solution containing 1 part of colchicine to 25 million parts of culture medium. In such cells the metaphase spindle appears normal or almost normal, but one of the chromosomes may be attached to the spindle near the pole. It gradually moves toward the equator. Anaphase begins as soon as it has joined the other chromosomes in the equatorial plate. A similar effect resulting from heat treatment—specifically, exposure of neuroblasts to a temperature of 45° C for 6 minutes—has been observed by Gaulden 36 minutes after treatment.

More recently Bloom, Zirkle, and Uretz (*6*) have found a similar phenomenon in untreated tissue culture cells of an amphibian, the newt. They report that, after breakdown of the nuclear membrane, one of the chromosomes in about half the cells is attached near the pole of the spindle at a time when the others are in the equatorial plane. After an interval that may amount to an hour or more, this chromosome moves to the equator. Once it has lined up with the other chromosomes, anaphase separation of the chromosome halves begins.



Figs. 1–6. Selected mitotic stages of the grasshopper neuroblast, redrawn from camera lucida sketches of living neuroblasts *in vitro*. Only a few of the chromosomes actually present are shown, these having been selected to illustrate chromosome position and orientation. *1*, Late telophase; *2*, late prophase; *3*, metaphase, in which one of the chromosomes is separated from the rest and the spindle is reduced in size after treatment with 2250-angstrom ultraviolet radiation; *4*, middle anaphase, demonstrating presence of invisible interzonal fiber (the black dot and arrow represent the microneedle and the direction of movement of the microneedle, respectively); *5*, early anaphase, illustrating stage when elongation of the spindle begins; *6*, middle anaphase, illustrating stage when elongation of the spindle ends.

I am inclined to believe that in these four examples we have the same situation, even though three were of treated and one of untreated cells. The feature that they have in common is an incomplete spindle. Incompleteness is due in the first three examples to retardation of spindle development by ultraviolet radiation, colchicine, or heat, and in the fourth to normal immaturity of the spindle. This chromosomal phenomenon raises three interesting questions.

First, why do most of the chromosomes retain their close proximity to one another with usually only one—or occasionally two or three—becoming separated from this main group? In my opinion we have to deal with two opposing forces when we attempt to analyze the prometaphase-metaphase movements and orientation of the chromosomes. One force tends to keep the centromeres of the chromosomes at the equator of the spindle and incidentally, therefore, in close proximity to one another. We may assume that this force involves an interaction of spindle and centromere. The other force is manifest as a repulsion between chromosomes. As a result of this force, the distal portions of the metaphase chromosomes radiate outward from the spindle like the spokes of a wheel, and there is a tendency in the grasshopper neuroblast for adjacent chromosomes to lie on opposite sides of the spindle equator (*7*).

It may be that in the partially destroyed or incompletely formed spindle the spindle-centromere force is reduced to the extent that the interchromosomal repulsion force is great enough to overcome it and move one or more chromosomes from the equator out along the spindle. Return of the separated chromosomes would then occur with restoration or development of the spindle to the point where the spindle-centromere force tending to move the chromosomes toward the equator is greater than the interchromosomal repulsion forces tending to keep them apart.

Second, why does the anaphase separation of chromatids begin only after all the chromosomes in these cells are in the spindle equator? All I can suggest is that perhaps the force that moves sister chromatids toward opposite poles of the spindle is not divisible functionally into a series of individual forces acting on the chromosomes independently but must act as a single unit in separating all the sister chromatids. This idea is supported by the nature of the physical changes that take place in the spindle during anaphase. Movement of the centromere groups to the poles is accom-

panied by liquefaction of the spindle material between them. It is difficult to interpret this as a series of liquefactions involving separately the different pairs of sister chromatids.

Third, why does the anaphase separation of chromatids begin as soon as the chromosomes in these cells are all in the spindle equator? The chromosomes of nearly all cells about which we have information normally occupy the metaphase position in the cell for at least a few minutes before anaphase separation of chromatids begins. In grasshopper neuroblasts at 38° C, metaphase lasts about 9 minutes. Therefore, something in addition to the metaphase orientation initiates anaphase. During this time the doubleness of the chromosomes becomes more pronounced, so that after a short time sister chromatids, though still connected along their whole lengths, are clearly distinguishable. This occurs at about the same rate whether or not the spindle has been altered by experimental agents. Probably there is some progressive change in the spindle that must attain a certain state in order to initiate anaphase. In cells in which the spindle is damaged by experimental agents or in which the forces acting between the spindle and chromosomes have not developed to the point where all the chromosomes have been moved into the equator, we might suppose that intrinsic chromosomal forces adequate for chromatid separation await only a certain condition of the spindle. As soon as the spindle has recovered or developed to the point where the last chromosome reaches the metaphase plate, anaphase separation is triggered off.

Anaphase Movement

If we are to consider intelligently the part the spindle plays in anaphase, we must first reach a common understanding of the physical nature of the living spindle and the changes it undergoes during anaphase. The metaphase spindle of the grasshopper neuroblast is a semisolid structure, which, together with the attached chromosomes, can be pushed about with a microneedle in the more fluid, surrounding cytoplasm (*8*). It maintains its shape as it is moved, unless it is pressed against the cell membrane. Then it is temporarily deformed, but on release of the pressure it gradually resumes its original shape. It is rigid enough to resist penetration by any but a very sharp needle, rolling to one side as the tip of a blunt needle is pressed against it. Spindle fibers are not visible, but there is good evidence of a longitudinal orientation of spindle components. If a microneedle is inserted into the spindle, it can be moved slowly toward the end of the spindle, eventually passing to the outside, but it cannot be moved through the spindle crosswise. Anaphase is marked by liquefaction and, during a limited period, elongation of the spindle. The evidence of elongation of the spindle is a gradual increase in the interpolar distance. Elongation begins soon after the proximal ends of the chromatids have started to separate (Fig. 5) and ends when the distal ends have mostly lost contact with one another (Fig. 6). Liquefaction begins at the equator as the chromosomes start to separate and extends progressively toward the poles with or slightly in advance of the separating centromeres. By middle anaphase all the original spindle is highly fluid except the small part between the centromeres and the poles, and this region has decreased in viscosity to such an extent that the microneedle can be moved through it with the displacement of only those chromosomes in its path. Mitochondria have moved into this region, where they show rapid Brownian movement. The only other nonfluid structures that can be demonstrated in this region are invisible strands known as interzonal fibers that are presumably derived from the outer nonstaining covering of the chromosomes and that connect the distal ends of the sister chromosomes. They can be demonstrated by moving the microneedle crosswise in this region, which causes a movement of the joined sister chromosomes in a similar direction (Fig. 4). The strength of these fibers is demonstrated by the fact that they can be stretched to several times their normal length without breaking (*8*).

Among the hypotheses that have been proposed to explain anaphase separation of chromatids are spindle fiber contraction, magnetic forces, electromagnetic forces, protoplasmic currents, interzonal region elongation, autonomous movement of chromatids, and various combinations of these. It is not my present intent to evaluate extensively the evidence for or against these various hypotheses, but rather to discuss some of my own experiments and observations that bear on this problem.

Anaphase separation of chromosome halves has often been assumed to depend on the division of their centromere. This is not true of grasshopper neuroblasts. (*9*). If these cells are exposed to x-rays, broken chromosomes in the form of proximal and distal fragments are produced. The former contain centromeres; the latter lack them. At metaphase, the fragments with centromeres are attached to the spindle, while the acentric fragments lie in or near the equatorial plate at its periphery. During anaphase, the sister chromatids of these acentric fragments separate. Usually their separation begins at one end and proceeds to the other end. We may conclude, therefore, that neither the centromere nor a force acting through the centromere is essential in separating the sister chromatids from one another. Their separation is apparently autonomous. It is, however, somewhat different from that of the chromosomes attached to the spindle. The chromatids of acentric fragments remain relatively straight throughout separation, while the normal chromosomes are bent close to the spindle, at an angle approaching 90 degrees, as if there were an additional separating force involving the spindle and centromere. Their movement apart after separation, however, is another matter, for acentric fragments do not move toward the poles at anything approaching the rate of the chromosomes with centromeres. As a matter of fact, whether or not they end up in different daughter cells seems to depend on whether they happen to be pushed by the constricting late anaphase cell against the interzonal fibers at just the right place. If this occurs, the elongating interzonal fibers may move the sister chromatids far enough apart that they end up in separate daughter cells.

My microdissection studies of the neuroblast have convinced me that the attachment of the chromosomes to the spindle is so firm at all stages of anaphase that we can disregard the magnetic, electromagnetic, and protoplasmic streaming hypotheses as possible explanations of this movement. Anaphase separation may be assumed probably to depend, therefore, on a pulling action of a contracting spindle or a pushing action of the interzonal region between the two sets of separating chromosomes, or both. Let us consider first the various evidences for a pulling action of the spindle.

1) An early concept of spindle structure and one still held by many biologists is that the spindle consists of microscopically visible spindle fibers, certain of which are attached to the chromosomes. This is the picture one sees after use of certain fixatives and stains. The biologist associates fibers with contraction and sees in fixed preparations that the later the anaphase, as evidenced by the distance between the daughter chromosomes, the shorter the spindle "fibers."

2) The jerking motions that we see in "moving pictures" of mitosis and meiosis look to the casual observer like tugging or pulling motions. Such pictures are, in a sense, not true motion pictures, but rather time-lapse photography, in which a series of pictures taken at intervals of a few seconds apart are run off at a rate of 16 or 32 per second. This not only greatly speeds up the normal

series of events but may actually be deceptive with regard to certain particulars. We have all observed in ordinary movies the spokes of a wagon wheel moving in the wrong direction, which would not happen if the individual frames had been exposed with less time interval between them. The actual speed of chromosome movements is so slow that the motion itself is not detectable as movement; hence, to look on these as jerking or tugging motions, as we commonly use these terms, is hardly justified.

3) A single chromatid that has two attachments to the spindle—that is, a dicentric—usually shows during anaphase a decreased diameter in one or more regions before a break occurs at some point. This has every appearance of a stretching effect with the separating force applied at the centromeres. It does not tell us, however, whether the force is a pulling or pushing one.

An explanation of anaphase chromosome movement that postulates a pulling or spindle fiber contraction force must assume that the poles are fixed; otherwise spindle contraction would be as likely to move the poles toward the chromosomes as the chromosomes toward the poles. The poles could be held apart either by astral rays connecting each pole of the spindle to the adjacent region of the cell membrane or by the so-called "continuous fibers" of the spindle extending from pole to pole. Astral rays, few in number and very delicate, are demonstrable with the microdissection needle in living neuroblasts and can be seen occasionally in fixed and stained neuroblasts. That they are not essential to anaphase, however, is proved by the fact that anaphase movement of the chromosomes continues as the microneedle rotates the spindle through 180 degrees to reverse it end for end, during which astral connections between poles and cell membrane cannot remain intact (*8*). Continuous fibers can sometimes be seen in fixed and stained preparations, but in the living neuroblast the whole interzonal region, except for the interzonal fibers connecting the distal ends of sister chromosomes, seems quite fluid, and it is not possible with the microneedle to demonstrate the presence of any continuous fibers extending from pole to pole.

The hypothesis of a pushing rather than pulling action is also supported by the effect of holding a needle tightly pressed against a metaphase cell adjacent to a pole of the spindle. Cell elongation at anaphase is partially prevented, but eventually the spindle and attached chromosomes, pressed tightly against the cell membrane, move some distance past one side of the needle (*8*).

Bělař (*10*), on the basis of extensive observations of meiosis in cells that had been shrunken or swollen by hypertonic or hypotonic salt solutions, respectively, concluded that after the initial separation of the chromatids the subsequent movement apart was the result of elongation of the *Stemmkörper*—that is, the part of the spindle situated between the separating centromere groups. In the grasshopper neuroblast, however, this is not the semisolid structure apparently visualized by Bělař in the grasshopper spermatocyte, but is a highly fluid region that I hesitate to call part of the spindle. By middle anaphase, all that resembles the original spindle is a semisolid cone between each pole and the set of daughter chromosomes approaching it. Liquefaction of the bulk of the spindle has taken place. Except for the mitochondria that have moved in from the cytosome, the only nonfluid structures between the separating sets of chromosomes are the interzonal fibers connecting distal ends of sister chromosomes. I suggested in a recent paper (*8*) that elongation of these fibers was probably responsible for much of the anaphase movement of sister chromosomes. Though the apparent "stretching" of dicentric chromosomes during anaphase and the movement to one pole of unpaired chromosomes at meiosis appear at present to militate against the universal applicability of this hypothesis, I believe the evidence at present for pushing is better than that for pulling apart of daughter chromosomes, at least in all except the initial stage of anaphase separation.

Summary

My conclusions, which, I confess, are tentative and based mainly on studies of one kind of cell, the grasshopper neuroblast, may be summarized as follows.

The late prophase orientation of the chromosomes is a carry-over from the late telophase orientation. It is apparently maintained by means of the centromeres, which appear to be attached within a limited region of the nucleus throughout telophase, interphase, and prophase.

Metaphase orientation of the chromosomes may be explained as the resultant of two forces: a force involving the centromere and spindle, which is responsible for keeping the centromeres in the equatorial plane of the spindle, and a repulsion force involving the noncentromeric portion of the chromosomes, which results in a tendency toward uniform spacing of the chromosomes outside the spindle.

Anaphase separation of sister chromatids and their subsequent movement toward the poles of the spindle involves at least four distinct phases: (i) the initial poleward movement of the centromeres, which may be due to intrinsic repulsion or to a force acting between spindle and centromeres that produces an angle of almost 90 degrees between the separated and unseparated portions of the chromatids; (ii) the autonomous separation of the noncentromeric part of the chromosome; (iii) elongation of the spindle, beginning just after the sister chromatids are separated proximally and ending when the longer chromatids are about to lose contact distally; and (iv) the later movement apart of the daughter chromosomes, probably resulting from a pushing force exerted by elongation of the interzonal fibers.

References and Notes

1. F. Schrader, *Mitosis* (Columbia Univ. Press, New York, 1953).
2. K. Sax and K. Mather, *J. Genet.* 37, 483 (1939).
3. K. Sax, *J. Gen. Physiol.* 25, 533 (1942).
4. M. E. Gaulden and J. G. Carlson, *Exptl. Cell Research* 2, 416 (1951).
5. J. G. Carlson and A. Hollaender, *J. Cellular Com. Physiol.* 31, 149 (1948).
6. W. Bloom, R. E. Zirkle, R. B. Uretz, *Ann. N.Y. Acad. Sci.* 59 503 (1955).
7. E. I. Shaw, unpublished observation.
8. J. G. Carlson, *Chromosoma* 5, 199 (1952).
9. J. G. Carlson, *Proc. Natl. Acad. Sci. U.S.* 24, 500 (1938).
10. K. Bělař, *Wilhelm Roux' Arch. Entwicklungs-mech. Organ.* 118, 359 (1929).

There is, I think, nothing in the world more futile than the attempt to find out how a task should be done when one has not yet decided what the task is.—ALEXANDER MEIKLEJOHN, in *Education Between Two Worlds.*

Some Limits to Popular Science

Travelers in foreign countries seem sometimes to believe that they will be perfectly understood if they speak loudly and clearly enough in their own language. Such a fancy is harmless enough, but it rightly makes ridiculous those who display it. Yet there seems to be growing up a similar belief which is scarcely less ridiculous but not entirely harmless—a belief that all the mysteries of science can be made clear to the layman if only scientists will take the trouble to explain themselves in very simple terms. In the circumstances of today it is undeniably desirable that the general public should have an appreciation of science in the widest sense—its discipline and its methods, its results and applications, its promises and its dangers, its organization and its practitioners. This aim is laudable, but no useful purpose is served by propagating the belief that there are no limits to the success which may be achieved.

Clarity of exposition is certainly of the greatest possible assistance here, as in the communication of any other kind of knowledge, and it is undoubtedly true that scientists have much to learn not only in explaining themselves to the layman but in explaining themselves to each other. Nevertheless, there are limits to what the most lucid thinker and writer can do when seeking to enlighten untrained and often unreceptive minds. This is true of all complex human activities, and it is curious that while it is so generally recognized in many other spheres it is so often ignored in discussing the popular exposition of science. An analogy can perhaps fairly be drawn from the ancient and widely played game of chess. All the world may appreciate that it is skill and patience which lead to victory or rejoice in the success of their local or national champion. But no one would suggest that the spirit of the game, the danger of a particular situation, the precise point at which the play turns in favor of one player or the other, and all the fine points mastered only after years of play, can be appreciated by those who do not know even the basic moves assigned to the pieces. This fact is accepted by those seriously minded newspapers which regularly have columns on chess—such columns are always written in a style designed to convey as much information as possible to the enthusiast, but make no pretense of catering for the uninitiated. This does not, of course, mean that nothing interesting can be said about chess in more popular publications. There, however, the emphasis must rightly be placed upon those limited parts of the subject which a wider readership will find interesting and intelligible. The result itself, the idiosyncrasies of the players, unusually brief or protracted play, can all be touched upon. But none would suppose that this kind of comment tells us wherein lies the absorbing interest of the game for those who play it or anything of the complex tactics which determine success.

The analogies can be multiplied almost endlessly. Can the tone-deaf appreciate a fine orchestral performance, or any but a trained jurist appreciate the subtle points of a complex legal argument? Again, however, there are parts of such matters which anybody with an inquiring mind can grasp even in the short time it is possible for the ordinary person to devote to the pursuit of, to him, relatively minor interests. Similar arguments can surely be applied to the popular exposition of science. Parts of the subject must surely remain a closed book to the layman virtually by definition; when he can read these pages he is no longer a layman but entitled to call himself a scientist, whether he reaches this status by institutional or private study. This is a fact implicitly recognized by all the most successful writers of science for laymen: their genius has been not in explaining science as a whole, but in explaining those parts of it which can be made intelligible and interesting to the ordinary person with very limited time to spare.

Generally speaking, unfamiliar matters, whether scientific or otherwise, can be understood so far as the reader can relate them to his own general knowledge and experience. He can appreciate the general nature of many major scientific discoveries, and he can understand their likely effect on his daily life if they were to be widely applied. That he ought to have this kind of knowledge is generally agreed. A high rate of technical development seems, whether we like it or not, to be the only answer to the acute problem presented by a world population that is both increasing rapidly and clamoring for a higher standard of living. To achieve this development, the widest and speediest possible dissemination of technical knowledge is essential, since the necessary decisions on policy are still largely in the hands of nonscientists.

Even on the purely factual side of science, however, there are many important discoveries which it is virtually impossible to explain to the layman in anything but the most superficial way, for they are too remote from his experience and ordinary modes of thought. It is, for example, surely no accident that while the major applications of chemistry are quite widely known, for they form part of our daily lives, the whole realm of theoretical chemistry has been virtually untouched by the popular expositor. The elegance of an ingenious organic synthesis or the nature of the dynamics of a complex reaction cannot be conveyed to those with no prior knowledge. The public, for example, may accept the fact that the elucidation of the structure of vitamin B_{12} is a great achievement, but they cannot be expected to see wherein its greatness truly lies.

There are other barriers to popular understanding. Science would be an uninspiring business if it consisted of no more than the collection of new facts and their application for practical ends. These are but the beginning and the rounding off of a complex process. To be manageable, facts have to be marshaled within the limits of general laws, from which in turn new facts may be deduced. Practical applications almost invariably call for the solution of problems scarcely less difficult—and, indeed, often more difficult—than those involved in the original discovery. Many nonmaterial factors also are involved: imagination to see the significance of facts, pleasure from the pursuit of knowledge for its own sake, the satisfaction of the creative impulse. It is surely unduly optimistic to hope that mere clarity of writing will suffice to convey to the layman a proper understanding of the whole complex intermingling of the material and the abstract which constitutes modern science. How long is it seriously supposed he can give to reading about this vast subject? Surely it is at the very best no more than will enable him to scratch at the surface, for even the individual scientist can today apply himself to only a very small part of it.

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In talking of the popular exposition of science it thus seems easy to confuse the part with the whole, to suppose that the present vast outpouring of popular scientific material represents all aspects of scientific activity. The point is not merely of academic interest; it is of considerable practical importance also. For better or for worse, scientists have a great, and still rapidly increasing, influence on world affairs; one can see no limit to the material achievements of science. Not surprisingly, there are grave misgivings about this, for it is only too apparent that evil as well as good can spring from scientific progress. That the great majority of scientists are interested in applying their work only to beneficial ends may be well known in scientific circles, but it would be complacent to suppose that all the world is convinced of this. Nothing could be more damaging to good relations between scientists and the public than a suspicion that they are deliberately hiding knowledge of their activities by describing them in language so esoteric and obscure as to be incomprehensible to any but their fellow experts. It would be far more useful, and less productive of disillusionment, to teach that science is in reality a strict discipline demanding patient application. If he really wants to understand science, and not merely its more obvious results and applications, the layman must be prepared to study it seriously. How this is to be achieved, however, in an age in which there are so many interests to occupy hours of leisure, entails argument far too controversial and complex to be embarked upon here. It does seem, however, that the time has come for more general introduction of science into primary education.

In the years to come, the world will inevitably turn more and more to science to solve the grave practical problems which beset it. The response will certainly be wholehearted, but one would have to be very optimistic to believe that there will be no disappointments. These will be all the greater if it is believed that science is really a relatively simple matter, for it could make failure seem the result of indifference or preoccupation with more sinister research, rather than of the intrinsic difficulty of the problems themselves. A limit to the extent to which science can help the world is set by the number of people who are able and willing to give the time and trouble necessary to acquire scientific knowledge appropriate to their purposes. This applies, of course, not merely to science but to all learning: superficial knowledge will never be an effective substitute for real understanding. It is rather easy to forget that it is not on science but on scientists that we depend for the solution of some of our pressing problems.

Edmund T. Whittaker, Mathematician and Historian

It is not easy to convey to those who did not know Edmund Taylor Whittaker the particular quality of the man that most impressed itself on his friends. One knew, of course, of the exceptional breadth of his scientific knowledge and the profundity of the mathematical problems to whose solution he had made such distinctive contributions, but, in his presence, these receded into the background without sacrificing the hue that they imparted to everything he said. He wore his great learning lightly like a flower. The simile indeed is singularly apt. I have happy memories of a visit to his Edinburgh home during which he showed to me and explained the peculiarities of more varieties of delphiniums than I knew existed. And when he turned to matters of philosophy or physical theory, one was hardly conscious of any significant change in the conversation. He had a way of speaking of the most abstruse developments in science as though they were things of the everyday, commonsense world that quite naturally fell out as they did. You wondered why you had ever thought them difficult.

Scarcely less striking than the depth and scope of his knowledge was his readiness to share it. When one needed to know whether a particular mathematical problem had been solved and, if so, where the solution was to be found, it tended to become a habit to write to Whittaker, and the reply was invariably prompt, full, and illuminated by comments of his own. He was equally familiar with the oldest and newest work on the subject, and it was a matter for wonder how he could keep abreast of the world-wide developments that were taking place in the extensive fields of his interests. In this respect, he was probably unique. By his death, an unparalleled spring of knowledge has been sealed up.

Whittaker grew up in such an age as he would probably have chosen had the choice been offered him. He received his introduction to mathematical physics at the culmination of the Newtonian epoch, when, in the words of Kelvin, only two clouds obscured the beauty and clearness of dynamical theory. Those clouds grew into the principle of relativity and the quantum theory, which were to fill the sky and leave the Newtonian firmament a memory as irrecoverable as the crystalline sphere of Ptolemaic astronomy. Whittaker was not only a spectator of this process but a participator in it and, in his last years, was almost the only survivor who could claim this distinction. He felt that this laid on him an obligation to make available the facts from his own knowledge as well as from the already published records.

He had already, in 1910, written a masterly history of ether and electric theory up to the end of the 19th century, and, by the time of his retirement from the chair of mathematics at Edinburgh University, the need for a revision of this valuable work created the occasion, and his newly acquired leisure the opportunity, for a new work that would not only review the field of the old but would also show how the subject developed into relativity and quantum physics and would carry the story forward to the year 1950. The first volume of this undertaking, which appeared in 1951, was a revised and amplified edition of the older work. The second, which was to have been the final one, came out in 1953, but the amount of material was so great that it had to be restricted to the years 1900 to 1926, and the work of the remaining years was reserved for a third volume. This, alas, we fear was never completed, but it is greatly to be hoped that enough was accomplished to make publication possible in due time. It is a work of the greatest value, not only to the historian but to all who seek a clear understanding of one of the most remarkable adventures in the history of thought.

Of Whittaker's original contributions to pure and applied mathematics, it is impossible to speak both briefly and intelligibly, and perhaps this is fortunate since, fundamentally important as they are, it was the catholicity of his mental

activity that one finds most memorable in him. He could not regard mathematics or physics as self-contained, specialized regions of knowledge. To him each was but one field of application of principles having universal scope, and those principles seemed to him to find an embodiment in the Roman Catholic church. He was received into that church in 1930. His essentially modern scientific outlook, however, made it impossible for him to accept the Neo-Thomist philosophy, and in a little book entitled *Space and Spirit*, published in 1946, he examined the philosophy of Aquinas in the light of modern knowledge.

Whittaker received some of the highest honors that the world of science can bestow. His greatest memorial, however, will be his influence on those who were privileged to know and learn from him.

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Harry J. Deuel, Jr., Student of Nutrition

Harry Deuel was born in St. Paul, Minnesota, 15 October 1897, the son of Harry James Deuel and Myrtle Lillian Deuel. After graduation from Carleton College he served for 3 years as a junior chemist in the office of home economics of the U.S. Department of Agriculture. Here it was that his long-sustained interest in nutrition had its early beginnings. As a candidate for the Ph.D. degree, which he received in 1923, he entered Yale University and came under the inspiring influence of Lafayette B. Mendel and of a laboratory actively engaged in nutrition research. After 5 years in the department of physiology at Cornell University Medical School and 1 year at the University of Maryland, he moved in 1929 to the University of Southern California as professor of biochemistry. Twenty years later, he was made dean of the graduate school. In 1946 he was elected to the board of directors of Annual Reviews, Inc., and assumed the presidency of the board in 1953.

Deuel's contributions in research, although they touched on many problems, were sharply centered in nutrition. A few of his earliest papers, published with Arthur L. Holmes, were on the digestibility of fat, a subject to which he returned in 1946. The digestion, utilization, and metabolism of carbohydrates first engaged his interest in 1919 and received his continuing attention for 30 years. He was equally, if not even more, interested in lipide metabolism and in such borderland problems as ketosis, in which he and his associates published intensively between 1932 and 1945.

While at Cornell University, he came under the influence of Graham Lusk and participated in a number of studies on animal calorimetry, especially in relation to protein metabolism. Although relatively few of his publications pertained to the latter, the particular study in which he found the greatest satisfaction fell in this area: "A study of the nitrogen minimum." For 63 days he maintained himself on a diet which, although adequate in total calories, was virtually free of protein. Nitrogen intake and nitrogen loss were determined. This study gave excellent confirmation to the numerical value assigned to one of the fundamental base lines in protein metabolism, the level of irreducible wear and tear of the body proteins—the unavoidable metabolic waste arising from cell activity.

The B vitamins, vitamin A, and the carotenoids were of consuming interest to Deuel and, in turn, led him into various investigations that were of a practical turn and impinged upon problems of great importance to the food industry. His work on the digestibility of various fats, on the nutritional equivalence of vitamin-fortified margarine and butter, and his testimony before a committee of Congress, contributed greatly to the eventual endorsement by public authorities of β-carotene-enriched margarine as a butter substitute. These studies led also to inquiries into other food additives, especially into some that were under consideration for use by the margarine industry. It was largely his work on isopropyl and stearyl citrates, proposed for prevention of the flavor reversion of refined soybean oil, that caused the U.S. Food and Drug Administration to permit the inclusion of these citrates in margarine.

Deuel's proof that the intermediary metabolism of sorbic acid is identical with that of caproic acid, and that it is of lower toxicity than benzoate, laid a solid foundation for the introduction of sorbic acid as a fungistatic agent by the food industry, especially in the packaging of cheese. As a tribute to the value of his work to the dairy industry, he received the Borden award of the American Institute of Nutrition in 1949. An enduring monument to a lifetime of devoted work may easily prove to be his authoritative and comprehensive two-volume publication, *The Lipides*. He was struggling to finish the third and final volume at the time of his death.

By his many friends, Harry Deuel will be remembered for the warmth of his friendship, his generosity of character, and his boundlessly enthusiastic and optimistic outlook. To his students and associates he had a very strong sense of loyalty. His interest in the many medical students and graduates who came under his influence was quite unusual. For many years he and Mrs. Deuel made it a practice to entertain at dinner the entire first year class of medical students. This was done in small groups throughout the year and was supplemented by similar activities, such as picnics and dinners, for the graduate students. In a large university, such social contacts of students with members of the faculty tend to be few indeed, although it may be pointed out that personal associations of this sort prove to be among the most treasured memories of a student.

In December 1954, with the onset of osteogenic sarcoma, he was obliged to undergo a hemipelvectomy. With characteristic optimism and remarkable fortitude, he endeavored to carry on as usual. Under a Fulbright fellowship he journeyed to England and the continent for a year of lecturing and further study, but, overcome by the advance of the disease, terminated his fellowship several weeks earlier than he had planned and returned to his home. He died on 17 April, a few hours after being elected to the presidency of the American Institute of Nutrition.

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News of Science

Loyalty-Security Program

The Special Committee of the Association of the Bar of the City of New York recently issued its report under the title, *The Federal Loyalty-Security Program* [Dodd, Mead and Company, (New York, 1956), xxvi + 301 pp.]. By special permission of the Bar Association, we reprint the following excerpts from the summary of the report, which constitute the recommendations of the committee.

A. Coordination and Supervision

1. The Director of Personnel and Information Security

(1) The Office of Director of Personnel and Information Security should be established in the Executive Office of the President.

(2) The Director should be appointed by the President subject to confirmation by the Senate and serve at the pleasure of the President.

(3) It should be the primary responsibility of the Director to conduct a continuous review of and supervision over:

(*a*) The personnel security programs, in order to assure efficiency, uniformity and fairness of administration, consonant with the interests of national security.

(*b*) The classification of information, so that only such information shall be classified as the interests of national security actually require.

(4) In the performance of his responsibility the Director should make recommendations to the President which, when embodied in regulations prepared by the Director and approved by the President, would be binding upon the departments and agencies concerned.

B. Scope

2. Scope of Personnel Security

(1) Clearance under the personnel security programs should be required for all sensitive positions and for no others.

(2) The head of each department or agency should designate as sensitive only those positions within his department or agency the occupant of which would

(*a*) have access to material classified as secret or top secret in the interests of national security, or,

(*b*) have a policy-making function which bears a substantial relation to national security.

(3) The President, on recommendation of the Director, should specify criteria in accordance with which the head of each department or agency should classify positions.

3. Classification of Information

The Director should continuously review and, after consultation with the agencies involved, make recommendations to the President concerning the standards and criteria and methods to be used in the classification of information and in its declassification when secrecy is no longer important to the interests of national security. These recommendations, when approved by the President, would be binding upon the departments and agencies concerned.

C. Standards and Criteria

4. Standard for Personnel Security

(1) The personnel security standard for all sensitive positions should be stated as follows:

"The personnel security standard shall be whether or not in the interest of the United States the employment or retention in employment of the individual is advisable. In applying this standard a balanced judgment shall be reached after giving due weight to all the evidence, both derogatory and favorable, to the nature of the position, and to the value of the individual to the public service."

(2) There should be no re-examination of cases already determined because of the change in standard here recommended, whether clearance has previously been granted or denied.

5. The Employee's Associations

A person's associations with organizations or individuals may properly be considered in determining his security suitability. But a conclusion against his security suitability on the ground of such associations should not be reached without adequate basis for determining that he shares, is susceptible to, or is influenced by, the actions or views of such organizations or individuals.

6. The Attorney General's List

(1) The Attorney General's list of subversive organizations should be abolished, unless it can be and is modified and revised in the following respects:

(*a*) The list should not include any organization which has been defunct more than ten years. [Information as to such organizations, however, would be available under the procedures set forth in paragraph (2) of this recommendation.]

(*b*) The list should give information as to the period and the general nature of the subversive activity of each organization listed.

(*c*) The list should be kept up to date by periodical supplements eliminating organizations which have been defunct over ten years and adding new organizations found to be subversive since the last publication.

(*d*) The list should include only those organizations which have been given notice and an opportunity to be heard in conformity with the requirements of due process of law.

(*e*) The list should contain a statement that mere membership in any of the organizations listed is not in itself to be construed as establishing the subversive character of a member unless membership has been made illegal by statute.

(2) The Department of Justice should upon request make available to security personnel and boards relevant information in its files concerning all organizations, whether defunct or not, the character of which may be pertinent in a pending inquiry. Such information may be taken into consideration in the inquiry together with all other evidence presented.

D. Personnel

7. Security Personnel

Personnel engaged in security matters should be individuals whose qualities and standing will inspire confidence in the fair, wise and courageous administration of the programs. To this end the Director should establish training courses for security personnel. The training should include intensive and thorough instruction in

(*a*) the nature of Communism and the techniques of Communist espionage and infiltration in the United States and in other countries;

(*b*) the political history of the United States and of the world, especially in this century;

(*c*) constitutional and legal principles; and

(*d*) the relative reliability of various kinds of evidence.

E. Procedure

8. Central Screening Board

(1) A central screening board should be created in the Civil Service Commission. This board should have the responsibility, except as set forth in paragraph (3) below, of determining whether or not security charges should be filed against any person covered by a security program, whether a Federal or a private employee.

(2) The central screening board should act in panels of not less than three members. At least one member of each panel should be a lawyer, and at least one member should be a person whose only government employment is his work on the board.

(3) Subject to further action by the Director, the Atomic Energy Commission and the Department of Defense should continue their present methods of screening to determine whether or not security charges should be filed, unless they wish to utilize the services of the central screening board. The Director should determine whether any other department or agency may establish or maintain its own screening board.

9. Screening Procedure

(1) Screening boards should afford the employee an opportunity for an informal conference with the board or its representatives to answer adverse security information.

(2) When a screening board determines that charges should be filed, it should prepare a specific statement of charges. If a person charged contends that charges are not specific enough to enable him to prepare his defense, the board should, in the exercise of reasonable discretion within the limits of security requirements, determine what additional information shall be furnished him.

(3) Charges should include all adverse security information which is to be considered in making a security determination, except in extraordinary circumstances where security considerations clearly forbid.

(4) Every employee against whom a security question is raised should be entitled to have an attorney advise and aid him in preparing statements to be submitted to a screening board, and should be entitled to assistance of counsel during his appearance before the board, with such participation by counsel in the proceedings as the board deems proper.

10. Treatment of Charged Employees Pending Disposition of Charges

Pending the final disposition of charges against Federal employees or employees of private employers:

(1) The pay of suspended employees should continue.

(2) Employees under charges, if not retained in the positions held when charges are filed, should be transferred without loss of pay to nonsensitive positions instead of being suspended, whenever this is practicable and consistent with the interests of national security.

11. Hearing Boards

(1) Every charged employee, other than a probationary employee, should be entitled to a hearing before a hearing board of three members to be appointed by the head of the charging agency. One member but not more than one member of the hearing board should be an employee of the charging agency, at least one member should be a lawyer, and at least one member should come from outside the government service. In the alternative, a hearing board may be composed entirely of persons outside the government service but in such case also one member should be a lawyer.

(2) The Director should maintain a panel of qualified private citizens who are willing to serve on hearing boards, and appointment of the citizen members of such boards should be made from this panel.

(3) In the appointment of the members of hearing boards, consideration should be given to the value of continuity of service.

12. Hearing Procedure

(1) The charging agency should be entitled to have an attorney present at the hearing. He should have the duty and responsibility to see to it that all relevant facts known to him are brought out whether favorable or unfavorable. The attorney should not participate in the deliberations of the board or be present at them.

(2) It should also be proper for the charging agency to have other representatives, such as a security officer, at the hearing, but such representatives should not participate in the deliberations of the board or be present at them.

(3) Every charged employee should be entitled to have an attorney present at the hearing to represent him. The attorney should have the right to offer evidence and examine and cross-examine witnesses.

(4) Hearing boards should prepare written findings of fact and conclusions. These should be furnished to the charged employee for his use with only such deletions as are required in the interests of national security.

(5) The charged employee should be furnished a copy of the transcript of the hearing for his use in the proceedings.

(6) The security hearing should not be public.

13. Appearance of Witnesses and Confrontation

(1) Except as provided below, screening boards and hearing boards should have the power in their discretion to subpoena government witnesses and witnesses for employees and to permit the submission of evidence by depositions, interrogatories, affidavits, letters, and other written statements.

(2) When a subpoena is granted, reasonable allowance should be made for traveling expenses and a per diem fee.

(3) It should be the policy of the government to permit the employee to cross-examine adverse witnesses before a hearing board when the hearing board believes this important for the development of the facts, unless the disclosure of the identity of the witness or requiring him to submit to cross-examination would be injurious to national security.

(4) The identity of an informant who regularly provides or is employed to provide secret information should not be disclosed by requiring his appearance before a screening board or a hearing board or otherwise identifying him, whenever the head of the department or agency which obtained such information shall certify that the identification or presence of such an informant would be detrimental to the interests of national security. To the extent practicable and consistent with the interests of national security, certificates should be accompanied by data which would aid the board in evaluating the evidence given by the informant, including a statement of whether he obtained the information first hand or through hearsay.

(5) As to all other witnesses, including casual informants, and with due consideration of the national security and fairness to the employee

(*a*) the screening board should determine whether it desires a witness to appear before it for interview, and

(*b*) the hearing board should determine whether the witness should be produced for cross-examination, or whether because of special circumstances he should be interrogated by the board without the employee being present, or whether his evidence should be given to the board in other ways, such as by an affidavit or a signed statement. So far as consistent with the requirements of national security, a hearing board should make available to the employee the substance of all evidence it takes into consideration which was given by any witness whom the employee has not been permitted to cross-examine.

(6) In determining the probative effect of information given by informants who are not made available for cross-examination by the charged employee, under the exceptions contained in paragraphs (4) and (5) above, screening and hearing boards as well as appeal boards and agency heads should always take into account the lack of opportunity for cross-examination.

14. The Attorney for the Charged Employee and His Fees

(1) Every employee under investigation by a screening board or against whom charges are filed should be entitled to obtain an attorney of his own choosing to represent him.

(2) In the event an employee is cleared at the screening stage, he should be reimbursed in the amount of his reas-

onable attorney's fee, the amount to be fixed by the screening board. If the proceedings reach the stage of an agency hearing board and if the employee is later cleared, similar reimbursement should be authorized, the amount to be fixed by the hearing board.

(3) Employees of private employers contracting with the government should be entitled to reimbursement by the government for attorney's fees on the same basis as government employees.

(4) Bar associations are urged to make provision through lawyer reference plans or otherwise for adequate representation of employees in security proceedings.

15. Final Determination

The head of the charging agency should have the power to make the final security determination.

16. Successive Security Determinations

(1) It should be the policy of the government to prevent insofar as is practicable and consistent with national security the repetition of security proceedings on substantially the same facts as to the same person, whether in the same agency or in different agencies.

(2) In the absence of new evidence a security clearance should not be reopened.

(3) When there is new evidence a security clearance should be subject to reopening only with the concurrence of the screening board and the head of the agency concerned. If a new hearing is directed, all relevant evidence, whether or not presented in the earlier proceeding, may properly be considered in making the new security determination.

(4) The regulations to be promulgated by the Director should include provisions for reciprocal recognition of clearness wherever feasible, and such regulations, upon approval by the President, would be binding on the agencies affected.

17. Applicants for Positions and Probationary Employees

(1) So far as consistent with the interests of national security, an applicant for a position covered by the programs who is denied employent should, upon request, in accordance with regulations to be established, be furnished with a statement of all adverse security information concerning him, such statement to be as specific as security considerations permit, or a statement that there is no such adverse information.

(2) An applicant furnished with a statement of adverse security information should have the right to file an affidavit denying or explaining it. Such affidavit should be placed in the personnel file which contains the adverse security information and should be part of any report of an investigation of the applicant.

(3) A governmental agency should also afford an informal interview to an applicant for, or a probationary employee in, a sensitive position so that he may have an opportunity to explain adverse security information, in any case where the general counsel of the agency recommends that an interview be given because of the importance of the employment of the person to the agency.

F. Name

18. Name of the Program

The name of the personnel security programs as a whole should be:

"The Federal Personnel Security System."

The Committee believes that with the adoption of these recommendations the future personnel security system would be substantially free of the weaknesses and defects which have appeared in connection with the present programs. National security would be adequately protected and no reasonable citizen could feel that this was being achieved at the sacrifice of our basic principles of liberty and our sense of fairness.

Individuality in Chimpanzee Behavior

The high degree of anatomical variability among chimpanzees, even among those of the same species, is well known; and, as might be expected, physiological variability has also been recorded, even though investigations in this area have not been numerous. H. W. Nissen, on the basis of studies of 151 chimpanzees (all presumably of one species) at the Yerkes Laboratory in Orange Park, Fla., during a period of 25 years, concludes that the behavioral variability of these animals is even more striking than their anatomical and physiological variability [*Am. Anthrop.* **58**, 407 (June 1956)]. These observations are especially significant, since particular effort has been made to maintain uniform environmental conditions for some 60 animals born since 1939.

Excluding three obvious sources of individual variability,—namely, age, sex, and experience—Nissen considers only those instances of individuality that may have a genetic basis. Differences have been noted among adults in locomotor, postural, oral, and manipulative acts that have no apparent basis in differential experience—for example, extent to which bipedal locomotion is used, manner of quadrupedal gait, grooming, manner of eating, food preferences, manner of rocking or swaying, occurrence of thumbsucking. Furthermore, variability is also evident in more general behavior traits, such as intelligence, dexterity, skill, inventiveness, emotionality, drive, persistence, aggressiveness, and timidity—for example, thresholds of excitability, attitude of the mother toward her young, speed of learning, tool-using and instrumental problem-solving.

Nissen believes that the 57 chimpanzees now at Orange Park are as distinctive as an equal number of human beings drawn from any place on this planet. Although they do not differ in as many details of behavior—since the repertoire of human behavior is much larger—the range is sufficient to guarantee each chimpanzee its own individuality. It is well recognized that culture has a very great role in shaping human behavior and so producing variability therein. The Orange Park chimpanzees, however, show pronounced behavioral individuality, although they live in roughly the same environment. Nissen, however, emphasizes that this does not definitely prove that their behavioral variability was not environmentally determined, for it is possible that minute elements of early experience act cumulatively to produce wide variability in later life. But the same differences could well be produced by minute hereditary differences in endowment and propensities. Thus, on the basis of present knowledge, it appears likely that both environmental and genetic factors are involved in the production of individual variability in chimpanzee behavior.

Whatever future experiments along this line may reveal, it is obvious that Yerkes was entirely correct in calling the chimpanzee "a rugged individualist." —W. L. S., JR.

Patent Ruling

The received date printed at the end of an article in a publication can no longer be employed by the U.S. Patent Office to bar a patent to an inventor, according to a ruling by the Court of Customs and Patent Appeals. The court's holding reverses a long line of decisions of the board of appeals of the Patent Office.

The decision was handed down on 21 June, in the case of *In re Emil Schlittler et al.* Schlittler is vice president and director of research of CIBA Pharmaceutical Products Inc., assignee of the patent application involved in the decision. The legal issue involved in the case was of such widespread significance that three patent law associations—the American Patent Law Association, the Connecticut Patent Law Association, and the New York Patent Law Association—filed briefs *amicus curiae,* all of which urged reversal of the Patent Office's policy of reliance on the "received" date.

In its rejection of the Schlittler *et al.* application, the Patent Office relied on a single reference, which was an article in the *Journal of the American Chemical*

Society published in November 1948. Schlittler and Andreia Uffer, a research associate, had filed an application in the Patent Office that was entitled to an effective filing date of 21 May 1948.

It was conceded by the Patent Office that the article was not a proper reference on the basis of its publication date alone. However, at the end of the published article was the notation "Received April 30, 1948." The Patent Office's position, in line with previous decisions of the board of appeals, was that this notation at the end of the article constituted prima facie evidence that the invention was "known" by others prior to 21 May 1948, under a provision of the Patent Statutes.

The court, after reviewing numerous decisions, construing and interpreting the word *known,* concluded that the "placing of the article in the hands of the publisher did not constitute either prima facia or conclusive evidence of knowledge or use by others in this country of the invention disclosed in the article, within the meaning of the [statute]."

Toxicity of Ozone

Biologists at Armour Research Foundation of Illinois Institute of Technology will attempt to study the toxicity of ozone. The foundation is conducting the investigation for the U.S. Air Force School of Aviation Medicine, Randolph Air Force Base, Texas.

Six investigators, headed by Hans-Georg Clamann, physiologist at the school of Aviation Medicine, will expose themselves to controlled concentrations of ozone in A.R.F.'s ozone chamber. Because of its toxicity, only laboratory animals have been exposed to ozone until recently.

Clamann and his five associates from Randolph Air Force Base will expose themselves to from 1 to 10 parts of ozone to 1 million parts of air in an 8-day series of experiments. Previous experiments on laboratory animals showed that exposure to as low as 12 parts ozone to 1 million parts of air proved fatal to some animals within 3 hours. However, the dose required to kill 50 percent of the common laboratory animals is in the range of 20 to 35 parts ozone to 1 million parts of air.

Premedical and Medical Education

The possibility of combining premedical and medical education will be studied at Northwestern University under a 3-year $75,000 grant from the John and Mary Markle Foundation, and under a portion of a recent $300,000 grant from the Commonwealth Fund. The committee conducting the study is composed of faculty members drawn from the medical school, the college of liberal arts, and the graduate school.

In the proposed plan, a student would enter the combined premedical and medical course on graduation from high school. The course would last 7 or 8 years and would present a unified progression of study in the arts and in the physical, biological, and medical sciences. There would be no sharp break between premedical and medical education; education in all fields would continue throughout the program.

First steps to be taken by the committee will be to examine ideas and methods of premedical and medical teaching now used, and the implications of recent advances in medicine in treating diseases. They will also study the facilities and personnel that the program would require, and they will collect and analyze opinions, ideas, and suggestions of students, doctors, and faculty members throughout the country.

Two of the problems to be solved in setting up a program will be in designing the courses so that a student could logically branch out into other fields allied to medicine if he desired to drop his training to be a physician, and to design the program so that graduates from other liberal arts colleges may enter the medical program at Northwestern.

AEC Foreign Agreements

The United States has negotiated agreements with France, Switzerland, and Australia for cooperation in the peaceful uses of atomic energy. All agreements take account of the arrangements that may be considered if an international atomic energy agency is created, and all specify safeguards and controls necessary for the safe use of fissionable material.

The agreement with France permits the exchange of unclassified information on the development, design, construction, operation, and use of various types of research, experimental power, and power reactors. Further data will also be transmitted on health and safety problems and on the use of isotopes in industry, agriculture, medicine, and biological research. Subject to agreement by the two countries, specialized research facilities and reactor materials-testing facilities within France and the United States will be made available for mutual use. Provision is also made for collaboration between private organizations of the two countries.

The United States has undertaken to provide France, subject to the conditions of the agreement, 40 kilograms of contained uranium-235 in uranium enriched up to a maximum of 20-percent uranium-235. Further, the U.S. Atomic Energy Commission may sell a portion of this material enriched up to 90 percent with uranium-235, for use in a materials-testing reactor. Finally, the French Atomic Energy Commissariat may obtain gram quantities of plutonium and uranium-233 for experimental projects.

The agreement with Switzerland provides that the United States may sell to the Swiss Government uranium containing up to 500 kilograms of uranium-235. Most of this fuel will be enriched up to 20 percent with the uranium-235 for use in research, experimental, and power reactors. However, Switzerland may also obtain 6 kilograms in a 90-percent enrichment for fueling a materials-testing reactor.

The agreement also permits the transfer of equipment and devices, as may be agreed, for use in the civilian atomic energy program of Switzerland and the transfer for research purposes of gram quantities of plutonium, uranium-233 and uranium-235. Authority is provided for purchase of other reactor materials. The new agreement is separate from the research agreement for cooperation, covering exchange of unclassified data on peaceful applications of atomic energy which has been in effect since 18 July 1955.

The agreement with Australia provides for the sale of up to 500 kilograms of uranium enriched up to 20 percent in uranium-235, for use in research, power demonstration, and power reactors. Up to 6 kilograms of this amount enriched in uranium-235 up to 90 percent may be sold to Australia for use in a materials-testing reactor. The agreement also provides for the transfer of equipment and devices, as may be agreed, and for the exchange of visits to research facilities.

Australia is an important producer of uranium ores from its Radium Hill and Rum Jungle areas. The United States buys part of this ore through the Combined Development Agency. The agreement provides that existing ore agreements and contracts will continue in effect and that the two governments will exchange information on exploration for and treatment and production of ores.

High-Altitude Studies of Solar Flares

Studies of the effects of solar storms or flares on radio fadeouts are being undertaken for the International Geophysical Year by the U.S. Naval Research Laboratory. Balloon-supported rockets were released from the *USS Colonial* (LSD-18), some 200 to 400 miles west of San Diego, Calif., during the last 2 weeks in July.

Ten 12-foot long rockets of the "Dea-

con" research type are being carried aloft by 68-foot diameter, "Skyhook" balloons to a height of approximately 80,000 feet. Each rocket carries an instrument load of 20 pounds and floats above the ocean until a solar "flare" is observed.

Inasmuch as solar "storms" rise to a maximum in a matter of minutes, NRL scientists using conventional rocket techniques have been delayed by the time taken, first, in detecting the flare from the ground, and then, in launching the rocket and gaining the altitude necessary for scientific observations. The ship-controlled balloon-rocket technique will reduce the delays. It is expected that a minimum time-lag of 90 to 120 seconds between the decision to fire and the attainment of the required observational altitude can be achieved by using this approach.

The decision to fire is based on the occurrence of a detectable solar flare. Detection can be achieved in two ways. One notice of a "flare" is the sudden radio "fadeouts" of the medium- and short-wave radio receivers aboard the ship. A second method makes use of an optical telescope coupled to a closed-circuit television system, with a red-colored filter corresponding to the light of a hydrogen flare. The picture of the sun as viewed on the TV screen shows the flare as a vivid flash.

When the decision has been made to fire a rocket, signals from a shipboard transmitter activate electronic instruments in the nose of the rocket, and also energize the receiver that controls the rocket igniter. As the rocket takes power, its pull shatters the plastic balloon, and in the next 90 to 120 seconds it attains an altitude of 60 to 70 miles in the ionosphere. In its trajectory it telemeters to the observing station aboard the *Colonial* data on the strength of x-ray and ultraviolet radiations from the "flare."

In addition to the telemetering transmitter, the "Deacons" contain photon counters sensitive to radiation from the sun in three wavelengths; 1216 angstroms, 1 to 10 angstroms, and 0.05 to 1 angstrom. These wavelengths correspond to the Lymanalpha line of hydrogen, x-rays, and "soft" gamma rays, respectively, which are believed to have independent but accumulative effects on the ionosphere, and hence on radio "fadeouts."

News Briefs

■ A suit that enables a man to work for several minutes at a temperature of 1200°F has recently been developed by the Minnesota Mining and Manufacturing Company, St. Paul, Minn. The suit is made of fiber glass coated with aluminum. The aluminum coating reflects much of the heat and permits the insulating layer of fiber glass to be much

less bulky than would otherwise be necessary to provide equivalent protection. Aluminum coats have also been bonded to cotton cloth and to asbestos for other specialized uses. The accompanying picture shows a demonstrator holding a wooden box inside a furnace. The box has burst into flame, but the demonstrator is unharmed.

Use of the suits is expected to save time and expense in the repair of equipment used in high-temperature installations.

■ Development of an iron lung that will automatically adjust itself to a patient's needs will be undertaken at Vanderbilt University under the supervision of Randolph Batson, associate professor of pediatrics.

The object of the development is to produce an iron lung that a patient can control through the muscle impulses he would normally use for breathing. Thus the patient himself will control both the rate and depth of breathing. Present respirator aids all tend to force the patient into a pattern of breathing that may not be precisely what he needs at all times. The key to the proposed device is the use of electrodes from which electric connections will lead from the patient to a controlling device for the iron lung. Thus, as the patient makes a normal attempt to breathe, an impulse resulting from the attempt will trigger the iron lung and the air will be forced into his lungs.

■ The Veterans Administration plans an enlarged medical research program under the record $10 million appropriated by Congress for the fiscal year that began 1 July. Most research will be concentrated in four areas of major diseases: mental, nervous, and brain diseases; heart and artery diseases; cancer and leukemia; and problems of aging.

The VA will expand its research program in tuberculosis, in the fungus diseases that resemble tuberculosis, and in the infectious diseases. It will support individual projects in such subjects as high blood pressure, hardening of the arteries, the metabolic diseases, and epilepsy and related nervous disorders.

In addition, the VA plans to enlarge its studies of drugs for the treatment of specific diseases, such as tuberculosis, multiple sclerosis, psychiatric disorders, high blood pressure, and cancer. The VA also will investigate changes in lung function due to aging and disease, and the effects of brain surgery in the treatment of schizophrenia. It will conduct two follow-up studies in order to make an evaluation of the natural course of coronary artery disease and coronary thrombosis and an evaluation of the long-term results of chemotherapy on tuberculosis. It also has a program in atomic medicine.

In all of these studies, the VA will be advised by the National Research Council Committee on Veterans Problems, the Statistical Agency of the National Research Council, and the Advisory Committee in Research of the VA, which is composed of outstanding leaders in American medicine.

Scientists in the News

ROBERT GRAHAM, dean of the University of Illinois College of Veterinary Medicine, will retire 1 Sept. A member of the faculty of the university since 1917, he was made dean of the College of Veterinary Medicine in 1945. Graham was the first scientist to detect botulism in animals, and the first to develop an antitoxin for botulinus, a form of food poisoning in human beings. In 1948 he was the first veterinarian to be appointed as scientific consultant to the Federal Pure Food and Drug Administration. Graham will be succeeded as dean by CARL A. BRANDLY, now chairman of the department of veterinary science at the University of Wisconsin.

The following are among those who have recently received honorary doctoral degrees.

University of Wisconsin: BENJAMIN M. DUGGAR, former professor at the University of Wisconsin and consulting scientist for the American Cyanamid Company.

University of Bonn: WEIKKO A. HEISKANEN, director of Ohio State University's Institute of Geodesy, Photogrammetry, and Cartography.

Carleton College: LLOYD H. REYERSON, chemistry professor, University of Minnesota.

Stevens Institute of Technology: DONALD A. QUARLES, Secretary of the Air Force; WILLIS H. TAYLOR,

JR., chairman of the Stevens board of trustees.

National University of Ireland: GERHARD HERZBERG, director of the division of pure physics, National Research Council of Canada.

PAUL B. SEARS, president of the American Association for the Advancement of Science and chairman of Yale University's conservation program, will be principal speaker at the annual field day of the Connecticut Agricultural Experiment Station, 15 Aug. His talk will be on the "Natural history of floods."

DAVID RITTENBERG has been named executive officer of the department of biochemistry at the College of Physicians and Surgeons, Columbia University. Rittenberg succeeds HANS T. CLARKE, who recently retired.

The following administrative and faculty changes have been made at the Medical College of Virginia: WILLIAM T. SANGER, formerly president of the institution, is chancellor; R. BLACKWELL SMITH, JR., of the department of pharmacology is president; and WARREN E. WEAVER, formerly chairman of the department of chemistry and pharmaceutical chemistry, is dean of the school of pharmacy. DAVID M. HUME, formerly assistant professor of surgery and director of surgical research at the Harvard Medical School, has been appointed professor and head of the department of surgery.

MARION S. OFFUTT has been appointed associate professor of agronomy in the college of agriculture and home economics of the University of Arkansas.

ROBERT M. BURNS, scientific adviser to Stanford Research Institute and to Sprague Electric Company, has been selected to receive the biennial Edward Goodrich Acheson gold medal and prize of the Electrochemical Society.

OTTO OLDENBERG, professor of physics at Harvard since 1930 and emeritus professor since 1955, has joined the staff of the Air Force Cambridge Research Center. At AFCRC he is working in the geophysics research directorate's atmospheric physics laboratory, where Air Force scientists are studying photochemical reactions in the high atmosphere.

C. ROGERS McCULLOUGH, assistant director of Monsanto Chemical Company's development department in the research and engineering division, has been appointed deputy director for hazards evaluation in the U.S. Atomic Energy Commission's division of civilian application.

MERRITT A. WILLIAMSON, manager of the research division of the Burroughs Corporation in Paoli, Pa., and lecturer on research administration at the University of Pennsylvania, has become dean of the College of Engineering and Architecture, Pennsylvania State University. On 1 Aug. he succeeded ERIC A. WALKER, who became president of the university.

JAMES H. WILLIAMS has been named assistant to the director of the Pearl River Laboratories of the research division of American Cyanamid Company. Williams was formerly director of the company's medicinal chemical research department.

JOHN E. MARTIN, associate professor of physiology and pharmacology in the School of Veterinary medicine of the University of Pennsylvania, has been appointed supervisor of research in experimental therapeutics in veterinary medicine at the university.

ROBERT O. FEHR has been appointed manager of the General Electric Company's Mechanical Engineering Laboratory, one of the four major units of the company's General Engineering Laboratory.

BRIAN L. HUTCHINGS has been named director of biochemical research in the research division of American Cyanamid Company. He was formerly assistant director of medicinal chemical research.

JOHN F. KRAMER, formerly on the faculty of the Yale University School of Medicine, has been named associate professor of psychiatry at the University of Chicago.

JULES FREUND, chief of the division of applied immunology at the Public Health Research Institute, New York, has been appointed a consultant to the National Institute of Allergy and Infectious Diseases, Bethesda, Md., to assist in establishing its new allergy-immunology program.

Recent Deaths

ELMER GRANT CAMPBELL, Orlando, Fla.; 80; professor emeritus of biology at the University of Georgia, University Extension, Atlanta; 7 June.

LEWIS R. CARY, Princeton, N.J.; 75; assistant professor emeritus in the department of biology at Princeton University; former member of the research staff of the Carnegie Institution of Washington; 11 July.

WALTER S. FORD, Yeadon, Pa.; 82; retired professor of electrical engineering at Drexel Institute of Technology; 11 July.

OSCAR E. HARDER, Columbus, Ohio; 73; authority on metallurgy; a founder and assistant director of Battelle Memorial Institute; 10 July.

DAVID MITCHELL, New Milford, Conn.; 71; retired professor of psychology for the Child Education Foundation; former staff member at Rutgers University, Teachers College of Columbia University, and the University of Pennsylvania; 7 July.

WILLIAM B. PEIRCE, Pittsburgh, Pa.; 78; retired vice president of research and development for the Flannery Bolt Co.; 4 July.

OTTO REINMUTH, Chicago, Ill.; 56; organic chemist; chemical research associate at the University of Chicago 1935–54; supervisor of the chemical literature section at the Armour Research Foundation of Illinois Institute of technology 1954–55; former managing editor of the *Journal of Organic Chemistry* and former editor of the *Journal of Chemical Education;* 23 June.

KARL SINGER, Chicago, Ill.; 54; director since 1947 of the department of hematologic research at Michael Reese Hospital; former research fellow at Beth Israel Hospital and Pratt Diagnostic Hospital and a former member of the Tufts University medical faculty; 12 July.

Education

■ The University of Texas this summer gave 28 high-school students a 5-week science program designed to accelerate their progress in college. The project, which was under the direction of Robert E. Eakin of the University of Texas, is being studied by an advisory committee from other Texas colleges to determine whether it should be widely adopted.

■ American Education Week will be observed this year 11–17 Nov. under the sponsorship of the National Education Association, the American Legion, the National Congress of Parents and Teachers, and the U.S. Office of Education. For more than 30 years the activities associated with this annual observance have encouraged a wider public understanding of, and support for, education at elementary and secondary levels. For the past 2 years a cordial invitation to participate has been extended to institutions of higher learning.

■ Physics students at Los Angeles High School will attend weekly lecture demonstrations given by scientists from the laboratories of the Hughes Aircraft Company. Under the same program, ten teachers, selected by members of the Los Angeles City School System, will

work on projects in the Hughes laboratories and attend special lectures on the uses of science in industry. The teachers' salaries, which will be comparable to those earned on teaching assignments, will be paid by the company. Employment is for the summer only.

■ Employment of retired scientists and engineers to meet the shortage in New York City of science and mathematics teachers may be recommended by the Advisory Committee on Science Manpower, appointed by the New York City board of education. A recent survey showed a current lack of 47 full-time science teachers. They are needed to staff 235 science classes in the high schools this September.

William Jansen, superintendent of schools, pointed out that the New York State education law requires teachers to have had a minimum of eight semester hours of education courses. But, he added, if a considerable number of retired scientists and enginers under the age of 70 are interested in teaching in secondary schools, he will urge modification of the present regulations.

Interested scientists should write to Samuel Schenberg, Board of Education, 110 Livingston St., Brooklyn 1, N.Y., enclosing a brief biographical sketch of their educational qualifications and scientific and industrial experience.

■ The special training division of the Oak Ridge Institute of Nuclear Studies has announced a partial list of courses to be offered through March 1957. A basic 4-week course in the techniques of using radioisotopes will open on 6 Aug., 3 Sept., and 22 Oct. 1956, 7 Jan. and 4 Feb. 1957. Two-week courses in veterinary radiological health for members of the armed forces veterinary corps will open on 17 Sept., 1 Oct., and 3 Dec. 1956; 4 Mar. and 18 Mar. 1957. For information and application blanks write to the Special Training Division, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tenn.

■ Massachusetts Institute of Technology and City College, New York, will each be loaned 5500 pounds of natural uranium by the U.S. Atomic Energy Commission (2500 kilograms). The metal, in the form of 8-inch rods enclosed in aluminum, will be used in subcritical assemblies in which nuclear fission can be produced but which will not sustain a chain reaction.

The facilities require no unusual safety controls, expensive shielding, or heat-removal equipment and may be used for many laboratory exercises in nuclear engineering training.

The subcritical assembly consists of an arrangement of the uranium rods in a moderator such as graphite or ordinary water. When a neutron source is introduced, a neutron flux can be obtained from nuclear fissions in the arrangement, but the reaction cannot be sustained without the presence of the neutron source.

This brings to five the number of loans of this type to educational institutions. Previous recipients were New York University, the University of Florida, and Virginia Polytechnic Institute.

■ The American Dental Association has announced that all five dental schools of Canada have been given full recognition by the association's accrediting agency. For the first time, dental schools of another country will be placed on the list of accredited schools issued by the association's council on dental education. The newly accredited dental schools are at McGill University, Dalhousie University, the University of Toronto, the University of Alberta, and the University of Montreal.

Grants, Fellowships, and Awards

■ Drugs to prevent or dissolve kidney stones will be studied at Georgetown University under a grant of $22,949 from the National Foundation for Infantile Paralysis. The group, under the direction of Martin Rubin, executive head of the chemistry department, is undertaking a systematic study of chemical agents capable of dissolving calcium salts from the urinary tract. The study will include both known agents and others of the same class to be newly synthesized. The object is to select agents that seem to offer the greatest promise for direct tests in human patients.

■ The Vanderbilt University School of Medicine has received a $200,000 grant from the China Medical Board, a foundation established originally to support medical education and research in China.

The poliomyelitis respiratory center at Vanderbilt University Hospital will continue its work during the coming year under a grant of $54,724.74 from the National Foundation for Infantile Paralysis.

■ The Foundations' Fund for Research in Psychiatry has been awarded a grant of $3,682,000 by the Ford Foundation. These funds are to be expended or committed during a 5-year period for the support of a program for the development of research personnel in mental health.

This new program will be maintained concurrently with the FFRP's present program of research grants in the field of psychiatry and related sciences. The selection of fellows and the awarding of research teaching grants will be the responsibility of a professional committee, which will work closely with FFRP's board of directors. Membership of FFRP's committee on fellowships is as follows: Douglas Bond, chairman; George Engel, Robert Holt, Robert Knight, H. W. Magoun, Neal Miller, and Ralph Tyler.

A brochure describing stipends, fellowships, and research teaching grants is in preparation and will be distributed during the summer of 1956. Copies of the brochure may be requested by writing to the Foundations' Fund for Research in Psychiatry, 251 Edwards St., New Haven 11, Conn.

■ The department of medicine of the Johns Hopkins Hospital and School of Medicine has entered into a contract with the Army Chemical Corps, Fort Detrick, Md., to conduct a broad program of laboratory and clinical investigation in the field of infectious disease.

The initial contract calls for a total of $267,330 to finance the research program for 2 years. However, the program will not be limited to the terms contained in this first agreement. Both funds and time will be increased and extended as the progress and findings of the studies may require. The program will be carried out under the direction of Ivan L. Bennett, Jr., associate professor of medicine and chief of the biological division of the Hopkins institutions.

■ Twelve research grants have been made recently by Eli Lilly and Company. The grants support one fellowship in bacteriology and projects including a study of drugs in leprosy; translations of Russian medical literature; carbohydrate metabolism studies; three programs on organic synthesis; programs on chemistry of natural products; connective tissue regeneration; blood coagulant mechanism; research on glucagon and insulin; and a study of acute rheumatic diseases.

■ Thirty-one research grants in 15 areas of study have been awarded by the Arctic Institute of North America for investigations in arctic science in 1956. This is an increase of nine over the number of projects sponsored last year and brings to more than 200 the field studies conducted by this organization to date.

Financial support is provided by the Office of Naval Research of the U.S. Navy, by the Sir Frederick Banting Fund, which is administered by the National Research Council of Canada, and by industrial and individual contributors. The grants-in-aid program is part of the institute's over-all effort to advance scientific understanding of northern North America through field and library research, publication, and the integration of research interests concerned with this area.

■ The American Association of University Women is offering 30 national fellowships for women for 1957–58. Ranging from $2000 to $4000, the fellowships are for graduate and postdoctoral research. Also available for 1957–58 are a number of international fellowships for American women with stipends ranging from $1500 to $2000.

■ The U.S. Fish and Wildlife Service has recently granted three research contracts for the study of problems in the shrimp, sponge, and tuna industries. Two of the projects will be conducted by the Marine Laboratory of the University of Miami. One, under a $19,900 contract, is an investigation of the causes and prevention of "black spot" on shrimp. The other, under a $12,000 renewal of a contract negotiated last year, is an investigation of Florida commercial sponges. The third project will be concerned with study of the tropical Pacific Ocean for the benefit of the tuna industry and will be conducted by the Scripps Institution of Oceanography under a $35,000 contract.

■ The U.S. Atomic Energy Commission has awarded 32 unclassified physical research contracts to universities and private research institutions. Eleven are new contracts, and the remainder are renewals of contracts that have been in force. The contracts were let as part of the commission's continuing policy of utilizing private research laboratories in conducting research related to atomic energy. Generally, the contracts are for a term of 1 year, and the institutions participate with the commission in defraying the costs of the research.

In the Laboratories

■ The new Southern California laboratories of Stanford Research Institute, a nonprofit public-service organization associated with Stanford University, have been formally opened. The South Pasadena buildings provide more than 38,000 feet of laboratory and office space for a staff of more than 100, which will conduct research in the three main divisions of the institute—physical sciences, economics, and engineering.

■ A new method of measuring the deflection of road surfaces under the stress of moving loads has been developed at Ohio State University's Engineering Experiment Station by Robert F. Baker of Ohio State and Robert D. Turpin, now of the University of Texas.

Strips of tape applied to the highway are photographed stereoscopically both before and during the passage of a loaded vehicle. The minute differences in the images are then measured at Perkins Observatory, near Delaware, Ohio, on a Gaertner measuring engine, which is accurate to 2 or 3 microns, and the deflections in the highway surface are calculated.

■ Armour Research Foundation of the Illinois Institute of Technology has been awarded two contracts totaling $63,575 to investigate the use of power lines and telephone systems as civil defense warning signal systems in event of enemy attack.

New Journals

Agricultural Marketing (successor to *Marketing Activities*), vol. 1, No. 1, July 1956. Milton Hoffman, Ed. (acting). Agricultural Marketing Service, U.S. Department of Agriculture (order from Supt. of Documents, GPO, Washington 25, D.C.). Monthly. $1.50 per year; 15¢ per copy.

Annales d'Histochimie, vol. 1, No. 1, Jan.–Mar. 1956. Société Française d'Histochimie, 45 rue des Saint-Pères, Paris, France. Quarterly. F.3000 per year.

British Chemical Engineering, vol. 1, No. 1, May 1956. William E. Dick, Ed. Heywood and Co., Ltd., Drury House, Russell St., Drury Lane, London, W.C. 2. Monthly. $6 per year.

Bulletin of the Florida State Museum, Biological Sciences, vol. 1, No. 2. William J. Riemer, Ed. Florida State Museum, Seagle Bldg., Gainesville, Fla. Irregular.

Bulletin of the Fund for the Republic, May 1956. Fund for the Republic, 60 E. 42 St., New York, N.Y. Available on request.

Chromatographic Methods, vol. 1, No. 1, Jan. 1956. H. Reeve Angel and Co., 52 Duane St., New York 7, N.Y.

GeoTimes (successor to the *Geological Newsletter*). Robert C. Stephenson, Ed. American Geological Institute, 2101 Constitution Ave., NW, Washington 25, D.C. Monthly. $2 per year.

Journal of Fluid Mechanics, vol. 1, pt. 1, May 1956. G. K. Batchelor, Ed. Taylor and Francis, Ltd., Red Lion Court, Fleet St., London, E.C. 4. $16.50 per year; $3 per part. U.S. agent, Academic Press, New York.

Journal of the Textile Machinery Society of Japan (English Edition), vol. 1, No. 2. Nov. 1955. Kiyohisa Fujino, Ed. Textile Machinery Society of Japan, 28, 2-Bancho, Namba-Shinchi, Minami-ku, Osaka, Japan. Semiannual. $1.50 per copy.

Mada (Science), vol. 1, No. 1, Jan. 1956. S. Hestrin and E. Katchalski, Eds. Weizmann Science Press, 33 King George Ave., Jerusalem, Israel. Quarterly. $5.50 per year; $1.50 per copy.

Nematologica, vol. 1, No. 1, Jan. 1956. J. H. Schuurmans Stekhoven, Ed. E. J. Brill, Leiden, Netherlands. Quarterly. $7.50.

Nickelore, vol. 1, No. 3. Anthony Toback, Ed. International Nickel Co., 67 Wall St., New York, N.Y.

Revue Française d'Etudes Cliniques et Biologiques, vol. 1, No. 1. Jan. 1956. *Editions Médicales Flammarion,* 22 rue de Vaugirard, Paris, France. 10 issues per year. F.6000.

Technical Digests, vol. 1, No. 1. Jan. 1956. European Productivity Agency, 3 rue Andrè-Pascal, Paris, France (order from OEEC Mission Publications Office, 2000 P St., NW, Washington, D.C.) Monthly. $24 per year.

Transactions of Chinese Association for the Advancement of Science, vol. 1, No. 1, Dec. 1955. S. M. Lee, Ed. National Taiwan Science, Museum, Taipei, Taiwan. Annual.

Your Radiologist, spring 1956. Hugh N. Jones, Ed. American College of Radiology, 20 N. Wacker Dr., Chicago, Ill. Quarterly.

Miscellaneous

■ The United States "Atoms for Peace" exhibit that was shown at the International Conference on the Peaceful Uses of Atomic Energy in Geneva, 1955, is now open to the public at Chicago's Museum of Science and Industry. Assembled by the U.S. Atomic Energy Commission in cooperation with private American companies and organizations, the exhibit includes models of five American atomic electric power plants, radiation detection instruments, and many atomic materials.

■ The department of botany of the University of Cincinnati has acquired a collection of 1450 specimens of European liverworts collected by the late Victor Schiffner of Austria. Only two or three duplicate sets of Schiffner's collections exist in the United States.

■ Among the articles in the August issue of *The Scientific Monthly* are "Protogenetics from Adam to Athens," L. P. Coonen; "Caste and the Jajmani system in a north Indian village," Oscar Lewis and Victor Barnouw; "Technical information—too much or too little?" Saul Herner; "Geomagnetic program of the International Geophysical Year," E. O. Hulburt; "Herman von Helmholtz: nineteenth-century polymorph," Howard Gruber and Valmai Gruber; and "Photosynthetic nitrogen fixation by blue-green algae," M. B. Allen.

In the "Association affairs" section there is information about the 123rd meeting of the AAAS to be held in New York, 26–31 Dec. Eight books are reviewed in this issue.

Reports

Speculations on Cosmogony

The recently reported conclusive evidence for the existence of the antiproton (*1*) encourages me to publish a speculation in which I attempt to extend to cosmogony a fundamental symmetry idea which has proved to be a valuable guide in the study of elementary particles—namely, the particle-antiparticle conjugation symmetry (*2*). This symmetry implies that, as far as the general laws of nature are concerned, neither a particle nor its antiparticle can have a preferred position. However, the part of the universe of which we have direct observational knowledge appears to consist essentially of only one kind of matter (nucleons and electrons). If it also contained a comparable amount of "antimatter" (antinucleons and positrons)—for example, in different stars of one galaxy, or in different galaxies, we would expect to notice effects of the large release of energy from the mutual annihilation of matter and antimatter (*3*) (in the form of light or of radio noise), since the stars within a galaxy, and probably also the different galaxies, are "in touch" with each other through an all-pervading, though tenuous, hydrogen atmosphere.

Some of the current theories of the origin of matter tacitly, or explicitly, assume an asymmetry in the process of "creation"—that is, the creation of nucleons, but not of antinucleons. According to the theory developed by Gamow, Alpher, and Herman (*4*) the present world originated from a dense neutron-rich atmosphere, the "ylem," which existed about 4.5×10^9 years ago and was transformed rapidly, by successive neutron capture and β-decay processes, into the elements which make up our cosmos. This theory makes the unsatisfactory tacit assumption that during some period the asymmetric "act of creation" of nucleons, in preference to antinucleons, took place an extremely large number of times (equal to the number of nucleons in the universe), and that it then stopped.

A similar tacit assumption of an asymmetry in creation underlies the "polyneutron" theory developed by Mayer and Teller (*5*) and Peierls, Singwi, and Wroe (*6*), which followed Lemaître's (*7*) original proposal of a "primeval atom," supposed to have contained all the nucleons of the universe (*8*). The hypothesis of the steady-state universe, developed by Bondi, Gold, and Hoyle (*9*), also assumes an asymmetry—namely, the continuous creation throughout all space of hydrogen atoms (consisting of protons and electrons), but not of their counterparts (consisting of antiprotons and positrons).

While initial conditions may have been asymmetrical, we may nevertheless ask ourselves: What would be the logical structure of a theory of the origin of the universe which attempts to preserve symmetry between nucleons and antinucleons? Should we simply assume that nucleons and antinucleons were originally created in pairs, that most nucleons and antinucleons later annihilated each other, and that "our" cosmos is a part of the universe where nucleons prevailed over antinucleons, the result of a very large statistical fluctuation, compensated by an opposite situation elsewhere? Could this statistical separation be so complete that we should not be able to detect occasional collisions of galaxies and "antigalaxies" with spectacular results, or considerable "background" radio noise from the voids in which hydrogen atoms meet "antihydrogen" atoms?

While these questions deserve further theoretical and experimental investigation, I should like to put forward here a speculation about a possible quite different preceding state of the universe which preserves symmetry in the initial conditions, but leads nevertheless to an apparent present asymmetry of matter in "our" cosmos.

If we want to preserve the particle-antiparticle conjugation symmetry at creation without assumption of a purely statistical separation of matter and antimatter, we have to consider models in which the cosmos and its possible counterpart, the "anticosmos," are somehow separated from the very beginning of their existence. Remembering the law of the conservation of nucleon number, such a "pair creation" might be achieved, perhaps in the simplest way, by the following modification of Lemaître's model (*7*).

We shall assume that there existed "at first" a single particle, containing the mass of the whole universe, which we shall call here the "universon." For reasons of symmetry we shall assume that it is a self-conjugate particle. We shall further assume that at a time $t = t_0$, unknown at present, the universon divided into a particle and its antiparticle which we shall call the "cosmon" and the "anticosmon," each possessing a large "nucleonic charge," but of opposite sign (where nucleonic charge is defined as $+1$ for a nucleon and -1 for an antinucleon). This division may be considered analogous to the spontaneous decay of a fundamental particle into a particle and antiparticle, such as one finds in the decay of $\theta^0 \rightarrow \pi^+ + \pi^-$, which takes place with a considerable release of kinetic energy, equivalent to approximately three-fourths of the rest mass of the two π mesons (*10*). The cosmon and anticosmon may have similarly flown apart with a large relative velocity (*11*). After the separation, the cosmon which replaces here Lemaître's primeval atom, and must therefore be assumed to be the particle of positive nucleonic charge, "decayed" at a time $t = t_1$, possibly through many intermediate steps, into nucleons, which in turn formed our present expanding cosmos.

Early stages of the cosmos may have resembled the "polyneutron" or "ylem," and the time t_1 may be close to the time at which our elements were formed, about 4.5×10^9 years ago. The anticosmon may or may not have decayed by now, since spontaneous decay is a process governed by a statistical law. If it did decay (forming an "anticosmos"), any antinucleons which are shot out with sufficient velocity to reach our cosmos will annihilate some part of it, possibly establishing a deviation from spherical symmetry in the distribution of matter in our cosmos.

These speculations suggest many questions, some of which are similar to questions raised earlier (*4, 7, 9, 12*). Some are of a philosophic nature; others may ultimately prove answerable by observation. The following may be mentioned.

1) Is the direction in space defined by the line connecting the centers of the cosmos and anticosmos detectable—for example, through detailed studies of the large-scale mass distribution in our cosmos, or of the large-scale average of the angular momenta of the galaxies?

2) Is the anticosmos itself detectable? How far away is it, and is it still receding from us?

3) If only a single universon existed, is it meaningful, even if only in principle, to ask any question involving a time preceding $t = t_0$?

4) Is it reasonable to assume the existence of particles of very large nucleonic charge (cosmon and anticosmon) in view

of the fact that the only particles known at present have a nucleonic charge of 0 or ±1; and why should the decay of the universon into particles of large nucleonic charge be a preferred mode?

It remains to be seen whether these speculations, which are most easily visualized in a Newtonian universe, can be formulated in a way that is compatible with the ideas of the general theory of relativity.

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References and Notes

1. O. Chamberlain *et al.*, *Phys. Rev.* 100, 947 (1955); J. M. Brabant *et al.*, *Phys. Rev.* 101, 498 (1956); O. Chamberlain *et al.*, *Univ. Calif. Radiation Lab. Rept. No. 3325* and *Phys. Rev.* 102, 921 (1956).
2. I should like to thank R. Schlegel for useful comments.
3. In a sufficiently dense environment, the total energy released in the mutual annihilation of electrons and positrons (1 Mev in the form of γ-rays) may be transformed into heat; up to about one-half the energy released in the mutual annihilation of nucleons and antinucleons (1876 Mev in the form of π-mesons, charged and uncharged) may be transformed into heat, the remainder being carried away by neutrinos, resulting from decay of the charged mesons. The decay modes of the π mesons are $\pi^0 \rightarrow 2\gamma$; $\pi^\pm \rightarrow \mu^\pm + \nu$; $\mu^\pm \rightarrow e^\pm + 2\nu$.
4. R. A. Alpher and R. C. Herman, *Ann. Rev. Nuclear Sci.* 2, 1 (1953); G. Gamow, *Creation of the Universe* (Viking, New York, 1952).
5. M. G. Mayer and E. Teller, *Phys. Rev.* 76, 1226 (1949).
6. R. E. Peierls, K. S. Singwi, D. Wroe, *ibid.* 87, 46 (1952).
7. G. Lemaître, *The Primeval Atom* (Van Nostrand, New York, 1950).
8. Gamow (see 4) suggests that one may escape discussion of the creation of the "ylem" or "polyneutron" if the "beginning," $\backsim 4.5 \times 10^9$ years ago, was only the latest beginning of an expansion of the universe which may ultimately be followed by a contraction and a new expansion, in endless cycles.
9. H. Bondi, *Cosmology* (Cambridge Univ. Press, Cambridge, 1952); F. Hoyle, *The Nature of the Universe* (Harper, New York, 1951).
10. See, for example, B. Rossi, *Nuovo cimento* 2, Suppl. 1, 163 (1955).
11. Other forms of pair-creation of cosmon and anticosmon, as well as processes leading to more than two particles, might be considered, as long as the essential assumption of the existence of particles of large mass and large nucleonic charge is maintained.
12. W. H. McCrea, *Repts. Progr. Phys.* 16, 321 (1953).

26 April 1956

Mechanism of Sound Production in the Sculpin

Definite information on the sound-producing mechanisms of many fishes has been obtained, especially on those of species possessing swimbladders and associated intrinsic or extrinsic muscles (*1, 2*). In many other species, including either those without swimbladder muscles or those entirely without swimbladders, this mechanism is less fully understood. For example, in marine sculpins, which are fishes lacking swimbladders, Fish (*2*) suggests a possible mechanism in *Myoxocephalus octodecimspinosus* Mitchill which involves pectoral-pelvic girdle vibration, and she describes two other mechanisms proposed by earlier investigators (*1, 3*).

In the experiments reported here (*4*), muscles considered to be primarily involved in sound production in the longhorn sculpin, *M. octodecimspinosus*, have been identified by use of electrophysiological techniques. These experiments suggest that a different mechanism is involved. Muscle-action potentials that were coincident with each burst of sound were detected by a cotton-wick electrode and a capacitor-coupled preamplifier that provided a gain of 44 db. The output was aurally monitored by a separate audio amplifier-loudspeaker circuit, displayed on a 5-in. oscilloscope, and recorded on magnetic tape by a Magnecord PT63 at 7.5 in./sec for detailed analysis and photorecording.

The action-potential pulses could be picked up from all parts of the body surface, increasing in amplitude in the vicinity of the gill chamber. The point of maximum amplitude (2 to 3 mv) was the posterior, dorso-lateral corner of the gill chamber on each side of the body near the junction of the posterior edge of the operculum with the dorsal body wall.

Careful dissection revealed the presence in that location of two muscles, one superficial to the other. Both muscles insert on the anterior edge of the cleithrum near the point of articulation of the latter bone with the supraclavicle. Both have their origin from the ventral surface of the skull, the deep muscle from the posterior region of the otic capsule just lateral to the midline and the superficial muscle from a more lateral region. Their contraction would thus produce adduction of the pectoral girdle relative to the skull. The homology of these muscles has not been determined with certainty. In some respects, they resemble either cephaloclavicularis or cucullaris muscles, but the deep muscle, at least, is innervated by branches of the first two spinal nerves rather than the vagus (*5*).

Electrophysiological recording directly from the surface of the exposed muscles indicated the deep muscle to be the source of the action potentials. That it is the only source is indicated by the fact that the superficial muscle could be completely removed without altering the nature of the spikes, and no other muscle site was found to yield such action potentials.

The relationship between the action potentials and the sound-producing vibrations was determined by comparing both separate and simultaneous oscillographic records of the two phenomena. The vibrations were detected by a crystal phonograph cartridge holding a stiff wire which rested near the coracoid

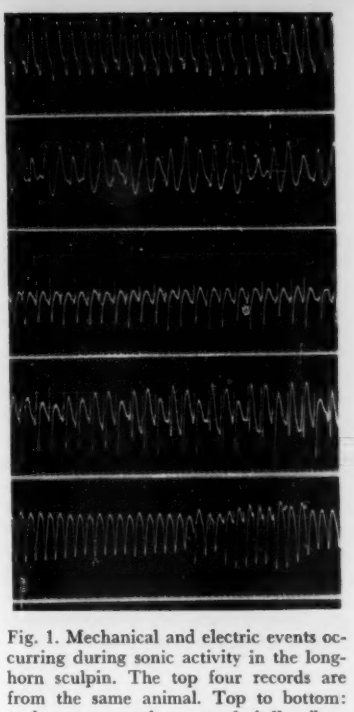

Fig. 1. Mechanical and electric events occurring during sonic activity in the longhorn sculpin. The top four records are from the same animal. Top to bottom: underwater sounds, pectoral-girdle vibrations, action potentials, simultaneous action-potential and pectoral-girdle vibrations, contractions of the deep cephaloclavic_laris muscle. Time marks occur every 10, 50, and 100 msec.

symphysis, where maximum vibration could be felt. The crystal output was connected directly to the oscilloscope input. For simultaneous recording, the two potentials were first combined in a two-channel audio mixer that had separate volume controls for amplitude equalization. Contractions of the deep muscle from one side of the body were recorded separately during sound production by tying the severed insertion of the muscle to the crystal pickup.

The following facts are evident from examination of the oscillograms. Typical examples are shown in Fig. 1. (i) Except for minor differences in records made at different times, the repetition frequencies of the muscle-action potentials, underwater sounds recorded by hydrophone, and pectoral-girdle vibrations are identical. (ii) The pectoral-girdle vibrations occur in phase with the muscle-action potentials. (iii) The deep-muscle contractions during sound production consist of a series of separate twitches, of which the repetition rate is similar to that of the phenomena reported here. The frequency difference that is visible in Fig. 1 between the bottom record and the preceding ones is apparently an individual variation.

Therefore, it is concluded that the

sound-producing mechanism of the longhorn sculpin is actuated by contractions of the deep cranioclavicular muscles on both sides. The resulting periodic movements of the pectoral girdle are believed to produce the actual sound vibrations of the surrounding medium. The previously suggested source of the vibrations, pectoral-pelvic girdle stridulation (*2*), was disproved by amputating the pelvic girdle, without injury to the pectoral girdle, in three specimens. For more than 24 hours after the operation, all three fish readily produced apparently normal sounds. In the absence of antagonistic muscles for the production of a reciprocating movement, it is suggested that the deep muscles produce unidirectional movement and that the return movement is produced by the elastic nature of the pectoral-girdle articulations.

Further analysis of the sculpin sound-producing mechanism is in progress. The preliminary results from this species suggest that analogous electrophysiological techniques may assist in providing positive identification of unknown-sound-making structures in other species.

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References and Notes

1. M. Dufossé, *Ann. sci. nat. Zool.* **19**, 53 (1874); **20**, 134 (1874); W. Sørensen, *J. Anat. Physiol.* **29**, 110, 205, 518 (1894); R. W. Tower, *Ann. N.Y. Acad. Sci.* **18**, 149 (1908).
2. M. P. Fish, *Bull. Bingham oceanogr. Coll.* **19**, 109 (1954).
3. T. W. Bridge, *Cambridge Natural History* **7**, 141 (1904).
4. Contribution No. 15 from the Narragansett Marine Laboratory of the University of Rhode Island. This research was conducted under contract with the Office of Naval Research. We are indebted to Marie P. Fish for calling our attention to the problem.
5. F. H. Edgeworth, *The Cranial Muscles of Vertebrates* (Cambridge Univ. Press, Cambridge, 1935), pp. 131, 142.

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21 May 1956

Some Effects of Specific Organic Compounds on Marine Organisms

In recent years it has become increasingly recognized that sea water contains organic compounds in solution or suspension which may have definite roles in the living processes of marine organisms (*1–3*). Thus it is reasonable to expect that a number of vitamins that may affect the bioeconomy of the sea are produced naturally (*4*).

This report describes two cases of interest which have come from our studies of the organic components of sea water. These results are considered to be significant because the presence of one of the compounds has been demonstrated by chemical methods (*2*) and because the other could easily be presumed to be present. In addition, both components showed definite physiological effects on the animals used.

Table 1. Effect of niacinamide on the pumping rate of an individual oyster.

Niacinamide (ppm)	Reduction in pumping rate (%)
0.42	52
0.83	83
2.08	99
3.33	99
10.00	100
50.00	100

During the experimental work of Collier *et al.*, various organic compounds were introduced into the water supply of experimental oysters [*Crassostrea virginica* (Gmelin)] in an attempt to obtain a response similar to that caused by the natural carbohydratelike substances (*5*). Niacinamide was among these, and although it did not cause an increase in pumping rate, its effect was pronounced and quantitative in nature. The effect was easily repeated from oyster to oyster under a variety of conditions. Briefly, the maximum effect was to cause an immediate increase in the gape (openness of the valves) of the oyster and, simultaneously, a complete cessation of pumping. The niacinamide was introduced into the water-circulating system in various concentrations. Table 1 summarizes the results of a series of experiments on a single oyster. The shell movement is difficult to quantitate, but, as the pumping rate decreased, the gape of the oyster gradually increased and, simultaneously, the adductor muscle lost tonus.

These data are typical, and it can be seen that the pumping rate was inversely related to the concentration of niacinamide. Some points to be noted are (i) that the substance was not acting as an irritant in the normal sense, because an irritant normally causes an oyster to snap shut or show frenetic shell movements, as compared with the quasi-narcosis in this case; (ii) that the valves could be pressed to the closed position but would immediately return to full gape; (iii) that the maximum gape caused by the niacinamide was actually about 10 percent greater than that associated with normal maximum pumping; (iv) that, as the niacinamide was gradually removed by dilution with normal, running sea water, the activity of the oyster resumed the level prevailing before the introduction of the vitamin; and (v) that niacin caused no response in similar concentrations.

Our work on the natural organic compounds in sea water is continuing and further tests with specific organic compounds are under way.

Of a series of compounds used with barnacles, ascorbic acid caused the most clear-cut response. When the barnacles (*Balanus* sp.) were exposed to a maximum concentration of 0.014 mg of ascorbic acid per liter, they immediately initiated copulating activities. The cirri ceased beating, and the penis emerged, unrolled, and sought out nearby barnacles. The ascorbic acid was introduced at one point, and because it was carried through the remainder of the 25-gal tank by convection drifts, all of the barnacles responded in the same manner. This would indicate that they were sensitive to much less than the original concentration. The experiment could be repeated at will with the same results, and changes in *p*H that were caused by adding HCl in place of ascorbic acid did not stimulate the response. The barnacles were fully grown animals that had been reared from larvae in the aquarium where the experiments were performed. These tests were made when the barnacles were 38 days old.

For comparison, glutamate, glycogen, methionine, and inositol were also used and seemed to stimulate a more rapid beat of the cirri. Fish autolysate appeared to depress the rate. None of these caused the responses noted for ascorbic acid.

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References and Notes

1. H. W. Harvey, *J. Marine Biol. Assoc. United Kingdom* **23**, 499 (1939); A. Collier, S. Ray, W. Magnitzky, *Science* **111**, 151 (1950); D. P. Wilson and F. A. J. Armstrong, *J. Marine Biol. Assoc. United Kingdom* **31**, 335 (1952); A. Collier, *Trans. North Am. Wildlife Conf.* (March 1953).
2. P. J. Wangersky, *Science* **115**, 685 (1952).
3. N. Takahashi, *Japan J. Ichthyol.* **2**, 69 (1952); R. Johnston, *J. Marine Biol. Assoc. United Kingdom* **34**, 185 (1955).
4. T. J. Starr, *Ecology*, in press; R. A. Lewin, *J. Gen. Microbiol.* **10**, 93 (1954); L. Provasoli and I. J. Pintner, *Proc. Soc. Protozool.* **4**, 10 (1953).
5. A. Collier *et al.*, *U.S. Fish Wildlife Service Fishery Bull. No. 84*, **54**, (1953); A. Collier and S. Ray, *Science* **107**, 576 (1948).

11 May 1956

Detection of Tumor-Inducing Factors in Drosophila

Many investigations have been concerned with the occurrence of melanotic tumors in *Drosophila melanogaster*. The effects of environmental modifications—that is, nutrition (*1*), temperature (*2*), and x-radiation (*3*)—on tumor incidence in various strains have been extensively studied. Melanotic tumors have been

Table 1. Response of a tumor-free strain (wild 51–52) to larval-extract injections of various tumor and tumor-free strains.

Donor strain	Larval hosts	Emerged adults	Tumorous adults	Tumor induction (%)
bw tu	647	68	48	71
tu-vg	770	96	61	64
tu-C-S	700	67	39	58
tu-w	697	41	22	54
+/f	400	49	11	22
tu^{36a}	400	54	0	0
C-S	414	53	0	0

produced in a tumor-free strain of *Drosophila* after the injection of hemolymph obtained from a tumorous strain of *Drosophila* (*4, 5*). A tumor-inducing factor, present in acellular *tu-e* larval extracts, when injected into hosts of a tumor-free strain, induced the formation of melanotic tumors which were histologically similar to the tumors present in the *tu-e* strain (*6, 7*). Recent research has been concerned with the activity, properties, and nature of the *tu-e* tumor factor (*8*). This survey was conducted to determine the prevalence of comparable tumor-inducing factors in seven other strains of *Drosophila melanogaster* (*9*).

The technique for the preparation of acellular 96- to 120-hr larval donor extracts, the injection apparatus and procedure, and the preoperative and postoperative care of the 96- to 120-hr host animals was essentially similar to that described by Harnly *et al.* (*6*) and Burton (*10*).

The host strain (wild 51–52) is a tumor-free strain from which no active tumor-inducing factor could be extracted (*6*). However, this strain is highly reactive to the injected tumor factor extracted from *tu-e* larval donors (*6, 10*). Repeated tests have conclusively demonstrated that neither operational injury (incurred in the insertion of the needle into the hosts or in the preoperative and postoperative procedures) nor the injection of diluting medium (Waddington's salt solution) induced tumors in the wild 51–52 hosts (*6, 10*). Barigozzi has also indicated that the trauma of the injection is not causal in the induction of melanotic masses (*4*). A histological study confirmed that injury or the injected diluting medium, or both, did not induce the formation of tumors in the wild 51–52 hosts (*7*).

Four known tumor strains, *bw tu, tu-C-S, tu-w,* and *tu-vg* were tested. Two other strains, *+/f* and *st sr e^s ro ca; tu^{36a}* (hereafter abbreviated tu^{36a}), which were considered to be possible tumor strains (not one tumorous imago was observed in a random sample of more than 500 animals of each of these two strains reared at 25°C on standard food, dissected, and examined) were also tested. The *C-S* strain was a tumor-free strain.

Only adult hosts were dissected and examined for the presence of melanotic tumors because those hosts that failed to reach the imago stage of development might have died before a possible tumor-inducing factor could have operated (Table 1).

Larval extracts of the four tumor strains and one of the purported tumor strains induced melanotic tumor formation in the wild 51–52 hosts, ranging from 22 to 71 percent. Injections of larval extracts of *C-S* and tu^{36a} strains failed to induce the formation of melanotic tumors in host animals.

These results demonstrate that extractable tumor-inducing factors may be obtained from tumor strains other than the *tu-e* tumor strain. However, not all tumorous strains, at least from donors of the age used, provide extracts that contain an active tumor-inducing factor. Extracts of one tumor-free strain (*C-S*) did not possess an active tumor-inducing factor.

Since tumor strains other than *tu-e* contain active tumor-inducing factors, it is very likely that these tumor strains also possess genes involved in the synthesis or activation of tumor-inducing factors or both. Nevertheless, a tumor strain of low incidence that does not possess an active tumor-inducing factor may contain genes that modify tumor gene activity or tumor-inducing factor activity or both (*11*). Indeed, under the proper conditions (ages of donors and hosts) active tumor-inducing factors may possibly be extracted from all tumor strains of *Drosophila melanogaster.*

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References and Notes

1. H. M. Briones, *Biologica* **10**, 55 (1949); W. J. Burdette, *Texas Repts. Biol. and Med.* **3**, 123 (1950); I. H. Herskowitz and W. J. Burdette, *J. Exptl. Zool.* **117**, 499 (1951); F. Friedman, M. H. Harnly, E. D. Goldsmith, *Cancer Research* **11**, 904 (1951); F. Friedman, *Trans. N.Y. Acad. Sci.* **17**, 294 (1955); S. Ghelelovitch, *Compt. rend.* **232**, 1776 (1951).
2. E. W. Hartung, *J. Exptl. Zool.* **106**, 223 (1947).
3. B. Glass and H. L. Plaine, *Proc. Natl. Acad. Sci. U.S.* **38**, 697 (1952); H. L. Plaine and B. Glass, *Cancer Research* **12**, 829 (1952).
4. C. Barigozzi, *Caryologia* **6**, 338 (1954).
5. M. C. Castiglioni and S. Beati, *Experimentia* **10**, 501 (1953).
6. M. H. Harnly *et al.*, *Science* **120**, 225 (1954).
7. L. Burton, M. H. Harnly, M. J. Kopac, *Cancer Research* **16**, 402 (1956).
8. L. Burton and F. Friedman, *Cancer Research*, in press.
9. This work was supported by postdoctoral fellowships CF-5154 and CF-5155 from the National Institutes of Health, U.S. Public Health Service.
10. L. Burton, *Trans. N.Y. Acad. Sci.* **17**, 301 (1955).
11. H. L. Plaine and B. Glass, *J. Genet.* **53**, 244 (1955).

5 May 1956

Osmotic Gradients across Cellular Membranes

In a recent article [*Science* **121**, 302 (1955)] W. A. Brodsky and others present arguments to prove that the Franck-Mayer hypothesis for the maintenance of osmotic gradients across cellular membranes is untenable for mammalian tissues. They state that the hypothesis would require a minimal energy expenditure of 21,000 kcal/kg hr to maintain the osmotic gradient obtained when mammalian kidney tissue produces a hypertonic urine. Since this value is about 1000 times the maximal rate observed for mammalian tissues, they conclude that the proposed mechanism is inadequate for the maintenance of the observed osmotic gradients.

It would appear that the authors have overlooked an important point in their analysis—namely, that the energy expenditure required is proportional to the tubular surface area *available* for water transport. The authors calculate the total tubular surface area to be 5×10^5 cm²/kg. This is 2 or 3 times larger than is generally assumed. However, such a discrepancy is of minor importance. Of crucial importance is the fact that the fraction of this total area which is actually available for water permeation may be quite small—for example, water may pass only through "pores" that occupy a small part of the surface area of tubular cells, or possibly only through a small percentage of the total number of cells. Much recent work indicates that flux rates across many living membranes as measured with isotopes can be easily accounted for by extremely small fractions of the total surface area of the membrane and that the area actually available for transport may, in many cases, be only a fraction of 1 percent. If the same is true for kidney tubules, the energy required to maintain the osmotic gradient obtained during production of hypertonic urine would also be only a fraction of 1 percent of that calculated by the authors' methods. Thus, a mechanism of the type proposed by Franck and Mayer does not necessarily demand an impossibly high energy expenditure.

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10 May 1956

Since Eugene Grim's comment raises some questions on the problem of intracellular osmotic gradients, it is important to restate the problem and to define some of the terms used.

The analysis considered the solute flux and intensity of respiration required for the steady-state maintenance of an os-

motic gradient within a cell under conditions of "idling"—that is, zero water transport. The term *solute flux* means the rate of diffusion of solutes per unit time, per unit area of cell, or per unit area of gradient-maintaining tissue. Intensity of respiration means the rate of energy expenditure per unit time, per unit mass of gradient-containing tissue.

Reduction of the surface area available for water permeation while fixing the cell width across which the concentration difference exists will reduce the total energy expenditure per unit time but *will not affect* the energy expenditure per unit mass of gradient-maintaining tissue, per unit time. Furthermore, such a reduction of "available" area demands that pores of cross-sectional area equal to that of the "available" surface extend across the fixed cell width like microcapillary tubes.

Incidentally, such a structural arrangement differs markedly from the Franck-Mayer scheme, where the gradient existed in an entire cell [*Arch. Biochem.* **14**, 297 (1947)]. Since the gradient would have to be maintained within the pore boundaries, a region of cell fluid would have to be insulated against diffusion between itself and the ambient intracellular fluid. Moreover, there must be a cellular device for funneling a significant fraction of energy from the surrounding cell fluid into the pore, since the energy expenditure per mass of gradient-maintaining region is much greater than that of the rest of the cell. Even if the tubular surface area were reduced to zero, the problem of maintaining a fixed gradient within a localized region (pore) of cell fluid would be the same as that reported previously [*Science* **121**, 302 (1955)]. If the pore extends through the cell membrane only, the osmotic gradient would be increased a 1000-fold, thereby offsetting the reduction of energy expenditure resulting from a decreased surface area.

The effect of reducing "available" surface area during the active transport of a finite volume of water is one of reducing the total energy expenditure while *increasing* the intensity of energy expenditure of the gradient containing tissue. Thus, selection of the appropriate surface area will yield reasonable rates of energy expenditure, but the aforementioned restrictions on pore geometry, funneling of energy, and intensity of respiration still apply. The velocity of flow of transported water increases as the permeation area is decreased, and the energy expenditure over and above that required for gradient maintenance during "idling" can be a small value. This means, as stated previously [*Science* **121**, 302 (1955)], that one cannot exclude rigorously any type of osmotic-gradient hypothesis for the active transport of water. It is pertinent to note that this analysis assumes no frictional resistance to the flow of transported water, no matter how high the velocity, and 100-percent thermodynamic efficiency of the gradient-maintaining mechanism. The minimum value for intensity of cell respiration during water transport is always greater than the value of 21,000 kcal/kg hr, reported previously for the condition of no water transport.

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25 June 1956

Ultrafractionated Ultraviolet Irradiation of Yeast Cells

The biological effect of a certain dose of ultrafractionated ionizing radiation was recently studied by Witte (*1, 2*), Witte and Sigmund (*3*), and by Hofmann *et al.* (*4, 5*). Using x- and beta-rays, they found definite minima in the effect on *Drosophila* pupae and eggs and *Escherichia coli* for certain selected frequencies, depending on the ratio of single exposure time (up to 10 μsec) to pause time, which varied from 1/2 to 1/9. This paper presents studies on the effects of ultrafractionated ultraviolet radiation on yeast cells.

The experimental arrangement consisted of a Hanovia quartz lamp (143 v, 1.3 amp direct current, no filter, 7-cm distance) with a motor-driven, aluminum strobic disk (8 circular apertures, each 7/8 in. in diameter, ratio of exposure time to pause time of 1/2). A powerstat provided regulation of motor speeds up to 2100 rev/min; disk speeds were measured with a strobotac. The test specimen was a strain (6) of Saccharomyces cerevisiae (7). Stock cultures of yeast were grown for 1 to 2 weeks on slants having the following composition: 1 percent dextrose, 0.5 percent yeast extract, 0.5 percent peptone, and 2 percent agar. After incubation at room temperature for 36 to 48 hours, the fresh slants were stored at 5°C. Cells washed from a stored slant into Sorenson's phosphate buffer at *p*H 5.4 served as inoculum for the liquid culture to be used in the experiments. By suitable dilution, the inoculum was brought to a standard optical density of 0.60 to 0.67 (compared with 0.00 for distilled water) as read on a Coleman spectrophotometer at a wavelength of 6000 A. Three 20-ml liquid cultures (media composition: 5 percent dextose, 0.5 percent yeast extract, and 0.5 percent peptone) were inoculated with 0.5 ml of cell suspension and then incubated without shaking at 30°C for 16 hours. After incubation, the pooled cultures were centrifuged at 200g for 5 minutes. The supernatant was discarded, and the residue was resuspended in an equivalent volume of Sorenson's phosphate buffer at *pH* 5.4. After the suspension had been centrifuged and resuspended twice more, the optical density of the suspension was brought to a standard of 0.60 to 0.67.

One-milliliter aliquots of the cell suspension contained in glass planchets (suspension depth of 0.4 mm) were used for radiations. The suspension was magnetically stirred to provide a more homogeneous dose. Times of 1 minute for

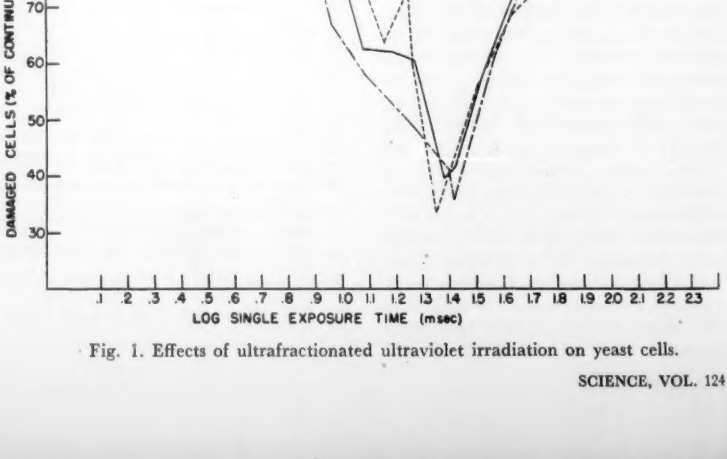

Fig. 1. Effects of ultrafractionated ultraviolet irradiation on yeast cells.

continuous radiation and 3 minutes for ultrafractionated radiation were used.

Immediately after irradiation, a drop of cell suspension was placed on each counting area of a hemocytometer slide. A drop of 0.5-percent aqueous eosin B (*8*) was mixed with each. The slide with cover slip was allowed to stand in subdued light for 10 minutes. Two hundred cells were then counted from each area. Stained and unstained cells were tabulated, and the percentage of stained cells was calculated. Maximum variation between the two 200-cell samples from the slide was 3 percent. The percentage of stained cells for 1 minute of continuous radiation served as a basis for testing the reproducibility of the method. The staining method was selected to indicate the early effects of, or damage by the radiation, or both.

The results of five experiments, covering single exposure times from 0.1516 sec to 0.0012 sec, are shown in Fig. 1. Starting at a single exposure time of 0.1107 sec, there was a decrease in the percentage of damage with decreasing single exposure time. A minimum in percentage of damage, averaging 36.7 percent of the continuous irradiation damage, was found at an average single exposure time of 0.024 sec. When single exposure times were further shortened, the percentage of damage approached the continuous irradiation value. A second minimum of less magnitude, averaging 77 percent of the continuous irradiation damage, occurred at an average single exposure time of 0.0025 sec. For further decrease in the single exposure time, the percentage of damage again approached the continuous irradiation damage. The straight line at 100 percent indicates the damage with continuous irradiation—that is an average of 65.2 percent of the total cells counted.

Similar to the findings of Witte (*1, 2*), Witte and Sigmund (*3*), and Hofmann *et al.* (*4, 5*) for ionizing radiation, ultrafractionated ultraviolet radiation also shows in its biologic effect a dependency on the frequency (single exposure time) of the incident radiation. Attempts have been made to interpret these findings in terms of the space and time distribution of the radiation-produced ions (*1*), as well as in terms of reciprocal actions between the radiation impulse and the restitutional pause (*4*). A theoretical approach to the problem by Krohn and Michie (*9*) proposed a radiation-produced chemical substance, the mean level of which is a function of the single exposure time. A possible explanation could be based on the "time-existence" of the radiation-induced chemical reactions. Photochemical studies by Allmand and Style (*10*) and radiochemical studies by Hummel *et al.* (*11*) have shown the usefulness of pulsed-radiation techniques in studying these reactions. These conclusions for chemical systems can be extended to biological systems with the assumption that a biological system behaves as a complex chemical system. Therefore, it is suggested that the minima observed in these studies on ultrafractionated ultraviolet irradiation of yeast cells are related to the "time-existence" of specific radiation-induced reactions.

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References and Notes

1. E. Witte, *Strahlentherapie* **82**, 209 (1950).
2. ——— *ibid.* **89**, 586 (1953).
3. ——— and R. Sigmund, *ibid.* **88**, 384 (1952).
4. D. Hofmann and K. Muller, *ibid.* **96**, 403 (1955); **97**, 64 (1955).
5. D. Hofmann and R. K. Kepp, *ibid.* **97**, 64 (1955).
6. Listed as No. 4125 in the *American Type Culture Catalog.*
7. J. G. Kereiakes, R. H. Hodgson, A. T. Krebs, *Army Med. Research Laboratory Rept. No. 195* (1955).
8. C. G. Fraser, *J. Phys. Chem.* **24**, 741 (1920); D. W. King *et al.*, *Cellular Research*, in press.
9. R. W. Michie, and L. H. Krohn, *Army Medical Research Laboratory Rept. No. 202* (1955).
10. A. J. Allmand and D. W. G. Style, *J. Chem. Soc.* **1938**, 596 (1930).
11. R. W. Hummel *et al.*, *Science* **119**, 159 (1954).

7 May 1956

Agronomic Use of an X-ray-Induced Mutant

In 1941, Genter and Brown (*1*) reported on the effects of varying x-ray dosages applied to the seed of *Phaseolus vulgaris* L. variety Michelite, a vine type of Navy or pea bean. Many different types of mutants were produced, and 90 percent of these were distinguishable within 5 weeks after emergence, 67 percent being chlorophyll abnormalities. No mention was made of any agronomic value being attached to any observed mutants. In 1941, progenies from this material without known mutants were planted in the regular breeding plots to insure against overlooking any valuable material. A mutant bush or nonvining type of bean that was smaller than Michelite and that matured about 12 days earlier than Michelite was found. Two years of testing proved the progeny of this mutant to be breeding true.

An attempt (*2*) was made to transfer the earliness of this mutant to the vine type by crossing and backcrossing to Michelite, followed by selection. The vine type of Michelite was found to be dominant to the bush and lateness was dominant to earliness. In this particular mutant, earliness and bush type were closely linked, so that no early vine type was obtained. However, during the process of selection, the size of the bush was increased considerably.

In 1948, the bean-breeding program of the Michigan Agricultural Experiment Station was made cooperative with the U.S. Department of Agriculture. At that time, a survey was made of the bean industry of Michigan to determine the priorities in bean improvement. It appeared desirable to develop a variety which might lend itself to harvesting by combine without pulling. It also appeared necessary that resistance to either bean anthracnose, which is caused by the fungus *Colletotrichum lindemuthianum* (Saec. and Magn.) Scrib., or to common bean mosaic, which is caused by *Phaseolus* virus 1 and its variant strain, be incorporated into any new variety which might be developed and released. The ultimate purpose of this would be to combine the resistance to these diseases in one commercial variety.

Several of the bush types that were recovered from the irradiated material were crossed to different anthracnose-resistant strains of beans belonging to a collection received from Cornell University. Four generations of back-crossing followed by five generations of selection resulted in a large number of anthracnose-resistant bush strains that were first tested in 1953. Twenty acres of one of these strains were grown in 1955. This strain has been named Sanilac and will be grown by foundation growers in 1956 for certification in 1957.

Table 1 compares the variety Sanilac with Michelite, the present variety which constitutes 95 percent of the 400,000 acres planted to Navy beans in Michigan.

The advantages of the new bush type, Sanilac, over the vine type, Michelite, can be enumerated as follows. (i) Sanilac is resistant to the alpha strain of bean anthracnose fungus, which attacks the Michelite and all other pea beans in Michigan. (ii) Because of better air movement resulting from the bush habit of growth, Sanilac has been found to be considerably less liable to injury by *Sclerotinia sclerotiorum* (Lib.) D By., the cause of sclerotinia wilt, or white mold disease, of beans. This is indicated by the differences in yield between the two varieties in 1953. (iii) The new variety is 6 days earlier than Michelite, indi-

Table 1. Yield comparisons and development rates of Sanilac versus Michelite (1953–55).

Variety	Yield (bu/acre)			Days to bloom	Days to harvest
	1953	1954	1955		
Sanilac	39.4	22.4	28.0	47	86
Michelite	22.0	24.6	23.1	53	92

cating that the linkage between earliness and bush type has been partially broken. (iv) Because of the upright type of growth of Sanilac, the ripe beans withstand the periods of wet and humid weather which frequently occur in Michigan during the harvest period, resulting in a lower percentage of discolored beans than is usual with the vine type.

The new variety is similar to Michelite in seed type, canning quality, and resistance to common bean mosaic. It is adapted to the better bean soils of Michigan and produces large upright plants, thus making up for loss of vines. More data are needed to determine whether Sanilac can be harvested by combine without pulling.

This agronomic use of an x-ray produced mutant may be added to those reported by Gustafsson and Tedin (*3*), who state "as far as we know, there are now three x-ray varieties released into the market, the Primex white mustard of Svalof, the 'Stråläart' of Weibullsholm, and, according to Knapp, the 'Schäfers Universal' in *Phaseolus*."

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References and Notes

1. C. F. Genter and H. M. Brown, *J. Heredity* 32, 39 (1941).
2. Journal paper No. 1908 of the Michigan State University Agricultural Experiment Station.
3. A. Gustafsson and O. Tedin, *Acta Agr. Scand.* 4, 636 (1954).

30 April 1956

Isolation of Dengue Virus from a Human Being in Trinidad

Epidemics of dengue fever have not been reported from Trinidad, British West Indies, in the past. Although some of the physicians on the island have made the clinical diagnosis of dengue fever, the presence of the disease has not been generally accepted. This brief report (*1*) describes the isolation from a human being in Trinidad of a virus that has been found to be related to previously isolated strains of dengue virus.

The patient (TRVL case No. 18) was an 18-year-old, white, unmarried, female resident of Port-of-Spain. She became ill on 16 Aug. 1953. The onset of illness was abrupt, with fever, muscle and joint pains, malaise, and headache as the chief complaints. A rash appeared on the following day, spreading rapidly over the face, trunk, and extremities of the patient. She did not visit a physician, however, until 20 Aug. 1953. At the time of the visit, her complaints were the same as those present at the onset of the illness and were not significantly changed in intensity. Her temperature was 100°F. A rash covered most of the body surface; it was a light red color and discrete and maculopapular in character. The rash faded on pressure. No other physical signs were found on examination. Her physician diagnosed dengue and informed the Trinidad Regional Virus Laboratory. A blood sample was obtained at this time and was inoculated intracerebrally into a group of 4-day-old mice and a group of adult mice. The clinical picture was so typical of dengue that no treatments other than salicylates were advised. The disease subsided during the next few days and the patient made an uneventful recovery, except for a somewhat prolonged period of convalescence, during which she complained of weakness and of becoming easily tired on exertion. A sample of serum was obtained during the patient's convalescence on 11 Sept. 1953.

Table 1. Results of cross-neutralization tests between dengue-1, dengue-2, and the Trinidad-1751 strains of virus and serums from immune rhesus monkeys.

Serum		Virus		
Monkey No.	Immunity status	Trinidad 1751	Dengue 1	Dengue 2
5007	Normal	4.6*	3.8	4.4
5007	Trinidad-1751 immune	< 1.0	3.4	2.3
5006	Normal	6.5	6.4	5.9
4975	Dengue-1 immune	4.2	2.6	5.3
4961	Dengue-2 immune	3.4	5.1	3.4
4963	Dengue-2 immune	2.6	4.2	3.0
5007	Trinidad-1751 immune	< 2.0	4.8	2.2
4975	Normal	4.6	Not tested	Not tested
4975	Dengue-1 immune	< 1.0	Not tested	Not tested
4961	Normal	> 5.4	Not tested	Not tested
4961	Dengue-2 immune	2.3	Not tested	Not tested

* Reciprocal of the logarithm of the 50-percent mortality end-point.

Definite signs of illness were first noted in the infant mice 12 days after inoculation. A brain suspension prepared from the sick mice was passaged into a group of adult and a group of 1-day-old mice. An agent that is lethal for young mice was isolated. No evidence of illness was observed in the adult mice. In the early passages, the incubation period in 1- to 2-day-old mice was from 7 to 10 days or more. The onset of the disease was characterized by irritability and marked ataxia. The disease developed rather slowly, and the mice gradually became prostrated and died. Occasionally a mouse was found with one or more legs paralyzed. On continued passage, the disease in the mice became more virulent, judging by the shortening of the incubation period and the duration of the disease. The incubation period became finally fixed at from 5 to 6 days. Following the inoculation of large doses of the virus, the disease lasted but a day or two from onset until death. It was found that the agent passed easily through bacteria-tight Seitz-EK pads. Suspensions that would produce the typical illness in mice failed to grow in ordinary broth or thioglycolate medium. The strain of virus is identified in this laboratory as TRVL specimen No. 1751.

The neutralizing capacities of serum samples obtained during the acute and convalescent stages of the patient's illness were compared with the neutralizing capacity of the homologous virus. It was found that the sample obtained during convalescence would neutralize about 1000 times more virus than the sample obtained during the acute stage. The serums were inactivated at 56°C for 30 minutes prior to being mixed with the virus suspension.

The virus has been adapted to adult mice following a series of passages in mice of gradually increasing ages. Although the incubation period and the duration of the disease in the adult mice are essentially the same as they are in the 2-day-old mice, the titers of virus in the adult-mouse brains have been lower, generally 10^{-5} to 10^{-6}. Titers of 10^{-7} and greater have been obtained with lower passage material when 2-day-old mice were used.

The clinical illness of the patient, together with the behavior of the virus in mice, strongly suggested that the agent might be a strain of dengue virus. Accordingly, studies were undertaken in this laboratory and by Max Theiler in the New York Virus Laboratories of the Rockefeller Foundation to test this hypothesis.

Normal rhesus-monkey serum and serums of rhesus monkeys that were immune to each of the known dengue strains, dengue 1 (Hawaiian) and dengue 2 (New Guinea "B"), and to the Trinidad strain (1751), were compared for their capacity to neutralize each of the corresponding virus strains (*2*). In the tests, tenfold dilutions of virus were mixed with equal volumes of serum. Following incubation, the serum-virus mixtures were inoculated into groups of six adult white mice, intracerebrally. In several of the

tests, the preimmunization serum from the monkey was available for comparison with the postimmunization serum. In other instances, a known normal serum was employed in the control titration. All the serums were inactivated at 56°C for 30 minutes prior to being mixed with the virus suspensions.

The significant data pertaining to the cross-neutralization tests are summarized in Table 1. The virus titers obtained in the presence of the various serums have been expressed as the reciprocal of the logarithm of the 50-percent mortality endpoint, which was calculated by the method of Reed and Muench (*3*). The results indicate an immunological relationship between the Trinidad strain and each of the two type strains with which the Trinidad strain was compared. Taking the results as a whole, it would seem that the Trinidad strain is somewhat more closely related to the dengue-2 strain than to the dengue-1 strain. However, the data are not sufficiently clear-cut to permit a final decision in the matter.

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References and Notes

1. The studies and observations on which this paper is based were conducted by the Trinidad Regional Virus Laboratory with the support and under the auspices of the Government of Trinidad and Tobago, the Colonial Development and Welfare Scheme, and the Rockefeller Foundation.
2. A. B. Sabin and R. W. Schlesinger, *Science* 101, 640 (1945); R. W. Schlesinger and J. W. Frankel, *Am. J. Trop. Med. Hyg.* 1, 66 (1952).
3. L. J. Reed and H. Muench, *Am. J. Hyg.* 27, 493 (1938).

16 April 1956

Characteristic Electrophoretic Patterns of Plasma Proteins of Orders of Amphibia and Reptilia

Immunological methods have been used for many years to study the phylogenetic relationships of animals (*1*). Electrophoresis would seem to offer another useful technique for such studies, since the electrophoretic patterns of the plasma proteins of an animal are characteristic, and distinct differences are found between patterns of closely related forms (*2*).

Paper electrophoretic patterns of the plasma proteins of amphibians and reptiles were determined under uniform conditions as part of a study of the comparative biochemistry of these forms. In each electrophoretic run, a parallel sample of human plasma served as a standard reference. All protein separations were carried out on an LKB paper-electrophoresis unit. A sodium barbital buffer of pH 8.6 with an ionic strength 0.05, containing 15 percent glycerol by volume, was used. A linear rate of movement of protein fractions was achieved by overcoming evaporation with the aid of the glycerol (*3*). Six 1-in. strips of Munktell No. 20 S filter paper were dipped into the buffer. Excess buffer was expressed from the paper with a rubber film roller. Seven hundred milliliters of buffer were added to each electrode vessel, and the two buffer surfaces were leveled with a siphon. The ends of the cassette holding the wetted strips were placed in the vessels. Following a 3-hour preliminary equilibration a potential of 170 v was imposed across the strips for an additional 3 hours. Two hundredths of a milliliter of fresh plasma was then spotted across each strip and fractionated for 17 hours at room temperature (26 to 28°C), 170 v, and 4 ma. Each strip was subsequently dried and stained with bromphenol blue (*4*). The optical density at 2-mm. intervals along strips made translucent with mineral oil was measured with a Beckman DU spectrophotometer at 590 mμ.

To date, we have examined about 1200 plasma patterns from more than 800 specimens of more than 100 kinds of amphibians and reptiles. Since genetic and physiological factors are known to influence plasma-protein composition, we have attempted to recognize such effects. Differences in the patterns due to sex, age, starvation, season, and geographic variation have been found (*5*).

The patterns of the various vertebrate orders that were studied seem to possess certain general diagnostic characteristics, provided that allowance is made for variations cited. In Fig. 1, a typical pattern from one species of each amphibian and reptilian order is shown adjacent to a "tentative key." The key is also in agreement with patterns obtained by

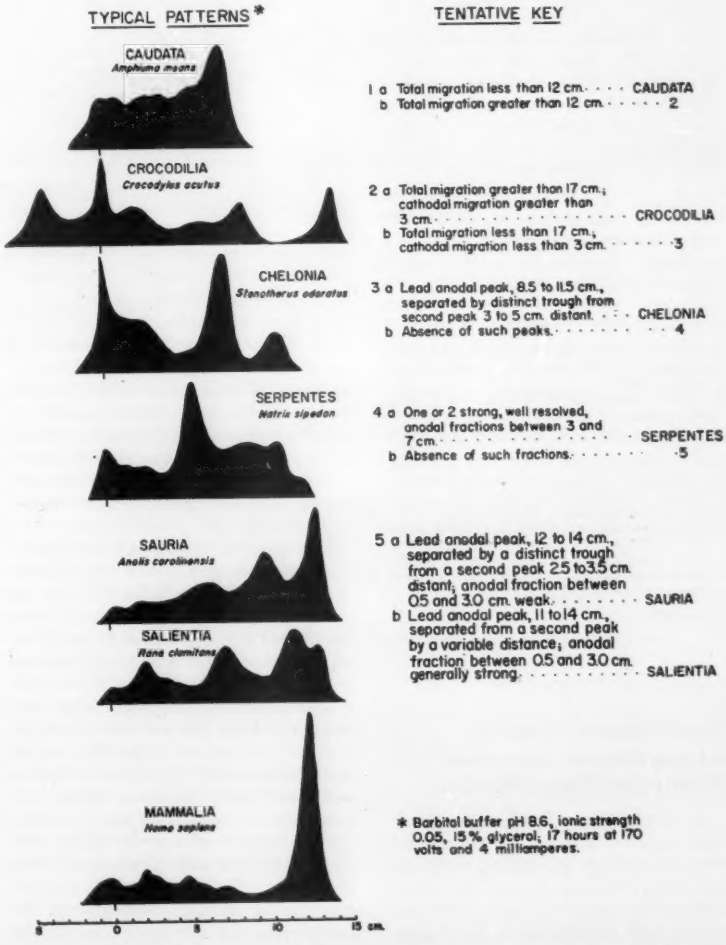
TYPICAL PATTERNS *
CAUDATA
Amphiuma means
CROCODILIA
Crocodylus acutus
CHELONIA
Sternotherus odoratus
SERPENTES
Natrix sipedon
SAURIA
Anolis carolinensis
SALIENTIA
Rana clamitans
MAMMALIA
Homo sapiens
0
5
10
15 cm.
TENTATIVE KEY
1 a Total migration less than 12 cm. . . . . CAUDATA
b Total migration greater than 12 cm. 2
2 a Total migration greater than 17 cm.; cathodal migration greater than 3 cm. . . . . CROCODILIA
b Total migration less than 17 cm., cathodal migration less than 3 cm. 3
3 a Lead anodal peak, 8.5 to 11.5 cm., separated by distinct trough from second peak 3 to 5 cm. distant. . . . . CHELONIA
b Absence of such peaks. 4
4 a One or 2 strong, well resolved, anodal fractions between 3 and 7 cm. . . . . SERPENTES
b Absence of such fractions. 5
5 a Lead anodal peak, 12 to 14 cm., separated by a distinct trough from a second peak 2.5 to 3.5 cm. distant; anodal fraction between 0.5 and 3.0 cm. weak. . . . . SAURIA
b Lead anodal peak, 11 to 14 cm., separated from a second peak by a variable distance; anodal fraction between 0.5 and 3.0 cm. generally strong. . . . . SALIENTIA
* Barbital buffer pH 8.6, ionic strength 0.05, 15 % glycerol; 17 hours at 170 volts and 4 milliamperes.

Fig. 1. Characteristic plasma protein patterns of the orders of Amphibia and Reptilia. Plasma samples were applied at the points indicated by the short line below each pattern. The anode is to the right of this mark.

other workers (*2*, *6*). Data such as total migration, movement toward the anode or cathode or both, and the presence or absence of specific fractions have been used as taxonomic characteristics. With this key, it should be possible to assign an amphibian or reptile to its proper order on the basis of the plasma pattern of the specimen. The key is based on patterns from 87 species distributed among the families as follows (*7*).

(Caudata) Proteidae, 1; Ambystomidae, 3; Salamandridae, 3; Amphiumidae, 1; Plethodontidae, 6. (Salientia) Bufonidae, 3; Hylidae, 5; Microhylidae, 1; Ranidae, 5. (Chelonia) Chelydridae, 1; Kinosternidae, 2; Emydidae, 5; Trionychidae, 1. (Crocodilia) Alligatoridae, 2; Crocodylidae, 1. (Sauria) Iguanidae, 4; Anguidae, 3; Xantusidae, 1; Teidae, 1; Scincidae, 2. (Serpentes) Colubridae, 30; Crotalidae, 7.

Since there are many major gaps in our preliminary survey of the Amphibia and Reptilia, it is very likely that this key will have to be altered as more data are accumulated. Thus far, however, these studies suggest that paper electrophoretic analysis is useful in revealing characteristics of plasma proteins that may serve as another means of illustrating basic similarities and differences between taxonomic groups.

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References and Notes

1. G. H. F. Nuttall, *Blood Immunity and Blood Relationships* (Cambridge Univ. Press, Cambridge, 1904).
2. H. F. Deutsch and W. H. McShan, *J. Biol. Chem.* 180, 219 (1949).
3. E. Valmet and H. Svensson, *Science Tools* 1, 3 (1954).
4. R. J. Block, E. L. Durrum, G. Zweig, *Manual of Paper Chromatography and Paper Electrophoresis* (Academic, New York, 1955).
5. A report of this work is in preparation.
6. T. L. Gleason and F. Friedberg, *Physiol. Zool.* 26, 95 (1953).
7. K. P. Schmidt, *A Check List of North American Amphibians and Reptiles* (Univ. Chicago Press, Chicago, ed. 6, 1953).

22 May 1956

Tissue-Culture Cultivation of Cytopathogenic Agents from Patients with Clinical Hepatitis

The susceptibility of a number of established cell lines of human and animal origin to a variety of selected strains of viruses, as well as to clinical specimens, from various diseases of unproved etiology is being investigated in our laboratories. During the course of these spectrum studies, an icteric serum specimen (MR_1), obtained from a patient presumed to have infectious hepatitis (*1*), apparently induced a destructive effect on an established line of spindle cells from human embryonic testicle (line PD 39T). Subsequently, confirming this original observation, a more striking cytopathogenic effect was observed on the Detroit-6 strain of human epithelial-like cells (*2*) in cultures containing this serum.

Table 1. Isolation of agents in Detroit-6 strain of cells from patients with hepatitis.

Designation	Test material	Data pertaining to cellular cultures			Calculated total dilution of original specimen
		No. of serial passages	Time cytopathogenicity observed (range in days)	Infectivity titer attained	
MR_1	Acute serum	6	6–9	$10^{-4.0}$	$10^{-9.2}$
Sal.	Acute serum	4	6–9	$10^{-1.5}$	$10^{-4.6}$
G. Pas.	Acute serum	6	4–7	$10^{-1.5}$	$10^{-6.0}$
G. Pas.	"Convalescent" serum	1	6–9		$10^{-2.0}$
D. Keb.	Acute serum	5	5–8	$10^{-1.0}$	$10^{-5.2}$
D. Keb.	"Convalescent" serum	1	6–9		$10^{-2.0}$
H. Pom.	Acute serum	7	5–8	$10^{-1.0}$	$10^{-8.2}$
H. Pom.	"Convalescent" serum	1	6–9		$10^{-2.0}$
New	Stool	5	6–9	$10^{-3.0}$	$10^{-5.0}$
Gar.	Stool	6	5–8	$10^{-1.5}$	$10^{-6.0}$
USA	Stool	2	6–9	$10^{-1.5}$	$10^{-3.2}$

A number of spindle and epithelial cell lines of human embryonic origin (skin, lung, liver, adrenal, spleen, uterus, fallopian tube, trachea) (*3*), as well as monkey kidney tissue, have not shown any degenerative change when they were inoculated with MR_1. In further studies with other cell lines, the original serum and fluids removed from the fifth passage in Detroit-6 cells have exhibited a similar cytopathogenic effect toward cultures of human amnion cells (*4*). In addition, after five passages in the Detroit-6 strains of cells, the harvested fluids produced a cytopathogenic effect on cultures of HeLa cells (*5*).

However, transfers beyond three successive serial passages have not been made in either amnion or HeLa cultures, and evidence for actual multiplication is as yet inconclusive. Syverton (*6*), while attempting to establish serum and infectious hepatitis virus in HeLa cell cultures, observed degenerative changes that were not transferable beyond three passages. Further work on use of the HeLa strain and amnion cells for primary isolation and maintenance of similar agents is in progress, but it appears to date that their susceptibility is of a lower order than that of Detroit-6 cells. The testicular line of spindle cells (PD 39T) used originally was lost in passage. Consequently, the studies reported here have been mainly with the Detroit-6 strain, in which the MR_1 agent has been passed serially without difficulty.

Following the repeated confirmation of the observation with MR_1, a number of similar transmissible agents, presumably viral in nature, have been isolated from tubes inoculated with serum and stools of patients (*7*, *8*) diagnosed as having clinical hepatitis. The specimens had been stored for variable periods at −70°C until tested. Young cultures of Detroit-6 cells have been used throughout the study, and the cells are washed three times with a maintenance solution consisting of mixture No. 199 (*9*) containing 10-percent horse serum to remove the human serum contained in the growth medium. The primary inoculum has been either 0.5 ml of 1/5 serum dilution or a 10^{-2} dilution of centrifuged supernate in the case of stool specimens.

Following 4 to 14 days of incubation at 36° to 37°C, the cell monolayer becomes disrupted and extended. Groups of small dark granular cells, irregular in size and shape, then aggregate in clumps throughout the culture. No inclusions have been noted, and areas of apparently normal cells are observed that indicate that all cells are not affected. Subcultures to younger cells are usually prepared at intervals ranging from 3 to 10 days, and characteristic cellular changes have been noted after each transfer.

Figure 1 shows the appearance of a control culture as observed in a fresh preparation (upper left) and stained with azure-eosin (upper right). The cytopathogenic changes produced by one of the agents (G. Pas.) is illustrated from a fresh preparation (lower left) and stained with azure-eosin (lower right). These cultures were incubated for 3 days and then were inoculated with virus, and the photographs (*10*) were taken following 8 days of incubation. Controls have consisted in simultaneous passage of serum from individuals with

no history of hepatitis as well as tissue-culture fluids obtained from uninoculated Detroit-6 cells. No antibiotics have been employed, and sterility tests on a number of media indicate that the tissue-culture preparations are free of bacterial contamination.

To date, experimentally transmissible agents exhibiting essentially similar cytopathogenic effect on the Detroit-6 strain of cells have been isolated from eight serums and three stools. Passage fluids capable of producing characteristic cytopathogenic changes have not shown evidence of any pathological effects in common laboratory animals or in embryonated eggs.

A summary of the data on the successful isolations from serum and stool specimens is contained in Table 1. Stool suspensions, as well as certain serums, may exhibit "toxicity" for cells in culture, but transmissible degeneration of this type seems improbable when one considers the total dilution of the original inoculum producing the specific cellular changes among the final subcultures. In addition, there has been a slight progressive rise in titer with each successive transfer as well as a decrease in incubation period required for cytopathogenicity. One serum (Sal) also produced degenerative change when it was inoculated into human amnion cells which could be passed to Detroit-6 but could not be transferred on passage to either amnion or HeLa cultures. This confirmed similar results with the MR_1 agent.

Seven serums obtained from laboratory personnel have been tested for ability to neutralize the cytopathogenicity of several of these agents. A serum obtained from the only individual (FT) known to have had hepatitis, 7 years previously, was capable of neutralizing the agents tested (D. Keb., Gar., G. Pas., MR_1). The other serums were negative, except that of one of the authors (RK_2), which showed a limited capacity to neutralize two strains (D. Keb. and Gar.). This serum was obtained following a mild illness that developed during the course of the work and had been diagnosed on the basis of laboratory and clinical evidence as probable infectious mononucleosis. An earlier serum from the same individual (RK_1) was without neutralizing activity. It has been reported that certain preparations of immune globulin are useful in clinical hepatitis (*11*). Therefore, two samples of commercial gamma globulin from different manufacturers were tested for their ability to neutralize representative agents of this group of isolates. One of the preparations at a 1/320 dilution neutralized the cytopathogenic effect; the other preparation was without effect at a 1/50 dilution.

Serums were obtained during convalescence (7) from three of the patients (D. Keb., G. Pas., H. Pom.) 2 to 3 months after acute illness. During an attempt to run neutralization tests against the homologous agent isolated in studies on the acute phase material, a typical cytopathogenic effect was observed in the serum controls on Detroit-6 cells. Therefore, even 3 months after onset and during convalescence, it appears that serums may reman infectious. The agents isolated from these "convalescent" serums appear in every way to be similar to the original isolates. This finding is not surprising when one considers the protracted clinical course of hepatitis. We are endeavoring to obtain later serum specimens from these patients and hope to be able to obtain serial stool and serum specimens from additional cases to substantiate further this finding.

On the basis of preliminary evidence, these agents appear to be filterable and relatively heat-stable. Material harvested from the fourth passage of Gar. was not inactivated by heating at 60°C for 30 minutes. Filterability through an 03 Selas has been established for the sixth passage of the G. Pas. agent. Similar studies on the other agents are in progress.

This unique group of similar viruslike cytopathogenic agents appear to be closely associated with cases of human hepatitis. However, it cannot be firmly ruled out to date that this group of agents is not originating from some of the components of the particular tissue-culture system. Final evaluation of their possible etiological significance in disease must await extensive clinical and serological studies as well as additional laboratory confirmation under carefully controlled conditions (*12*).

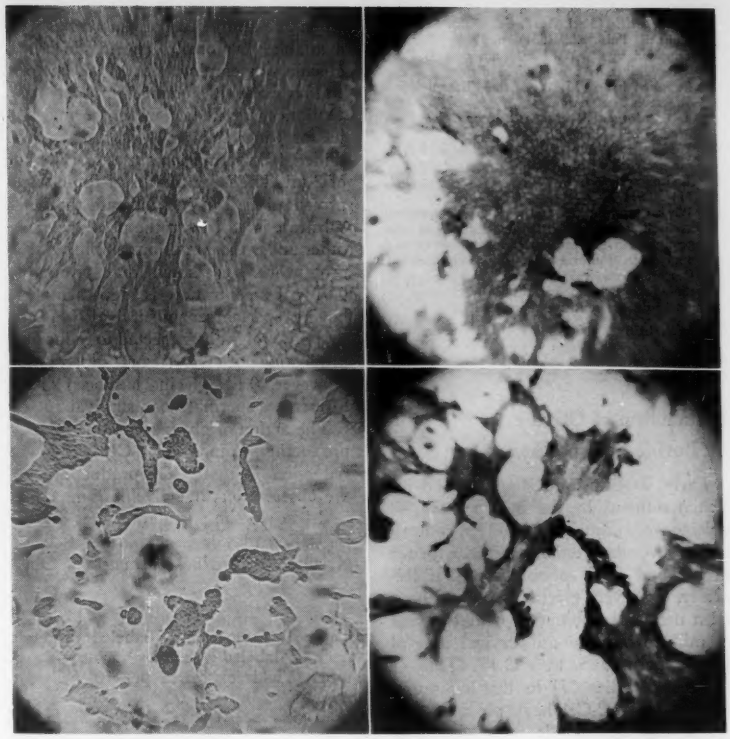

Fig. 1. Control cultures of Detroit-6 cells and changes produced by G. Pas. after 8 days of incubation. (Top) Control cultures unstained (left) and stained with azure-eosin (right). (Bottom) CPE produced by G. Pas. unstained (left) and stained with azure-eosin (right).

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References and Notes

1. Supplied by Franz Oppenheimer and Albert M. Wolf of the Michael Reese Research Foundation.
2. C. S. Stulberg *et al.*, *Proc. Soc. Expil. Biol. Med.* 89, 438 (1955); L. Berman *et al.*, *Blood* 10, 896 (1955); Detroit-6 cultures obtained from C. S. Stulberg.
3. Cell lines isolated in Parke, Davis and Company laboratories according to techniques previously described by R. S. Chang [*Proc. Soc. Expil. Biol. Med.* 87, 440 (1954)]. We are grateful to M. Hemans and R. Sarber, who supplied and maintained the tissue-culture preparations used throughout this study.
4. E. M. Zitcer *et al.*, *Science* 122, 30 (1955).
5. G. O. Gey *et al.*, *Ann. N.Y. Acad. Sci.* 30, 1057 (1954).
6. J. T. Syverton, in *Symposium on the Laboratory Propagation and Detection of the Agent*

of Hepatitis (Natl. Acad. Sci.–Natl. Research Council, Publ. 322, 1954), p. 17.
7. Supplied by R. W. McCollum and J. Paul, Yale University School of Medicine.
8. Supplied by A. M. Wolf, the Michael Reese Research Foundation.
9. J. F. Morgan *et al.*, *Proc. Soc. Exptl. Biol. Med.* 73, 1 (1950).
10. We are grateful to J. Weston and A. R. Taylor for preparation of the photographs.
11. J. Stokes, Jr. *et al.*, *J. Am. Med. Assoc.* 147, 714 (1951).
12. Work is continuing, and a report of progress, as well as further characterization of the group, is in preparation. Recent observations appear to indicate that different lines of Detroit-6 cells vary in their susceptibility to these agents, and certain cultures may be markedly less sensitive than others.

22 March 1956

Metabolism of Glycine by Bovine Spermatozoa

Early attempts to improve bovine semen diluents by the incorporation of glycine were unsuccessful (*1*), in contrast to the favorable response noted with sea urchin and fowl spermatozoa (*2*). Recently, however, glycine solutions have been used in combination with egg yolk or milk to increase the survival time of bovine spermatozoa at 5°C (*3, 4*).

Recent studies (*5*) in this laboratory with glycine-1,2-C^{14} have provided evidence that glycine is metabolized by freshly collected bovine spermatozoa. Previously, a metabolic role for glycine had received little consideration, since it apparently was not utilized (*2, 6*).

In a preliminary trial, 1.7 ml of whole semen containing 2×10^9 spermatozoa was incubated in a diluent of heated skimmilk and 0.5*M* aqueous glycine (1/1) (*4*) containing 4 μc of glycine-C^{14}. Respiratory CO_2, collected in alkali during 3 hours of incubation at 37°C, was converted to barium carbonate and yielded a total of 11,700 count/min.

Subsequent trials involved twice-washed spermatozoa suspended in Ringer-phosphate buffer containing 0.001*M* adenosine triphosphate. In experiment 1, 0.01*M* sodium formate was added as a metabolic trap (*7*); 0.01*M* glyoxylic acid was used similarly in experiment 2. Formate was recovered by steam distillation and was oxidized with mercuric oxide. Respiratory CO_2 and formate were radioassayed as solid barium carbonate. Glyoxylate was recovered as the 2,4-dinitrophenylhydrazone and was radioassayed as such. Results of these two experiments are presented in Table 1. Obviously, spermatozoa are capable of metabolizing glycine. The products recovered indicate that the pathways involved may be similar to those observed in other mammalian tissue (*7*).

Further evidence of the nature of glycine metabolism was sought by determining the glycine and glucose oxidation when one and when both substrates were available. Uniformly labeled glucose or glycine was employed in 0.01*M* concentration with 10^6 count/min, per flask. Osmotic pressure was within normal limits for these cells (*8*). Each flask contained 10^9 spermatozoa in a final volume of 2 ml. The mean results of three trials, presented in Table 2, indicate that each substrate is utilized in the presence of the other under the conditions employed. Recent work has shown that glycine at 0.01*M* concentration is detrimental to bovine spermatozoan survival (*4*) and therefore might be expected to reduce the production of CO_2 from glucose-C^{14}. However, 0.1*M* glycine has been shown to increase spermatozoan survival (*3, 4*).

The action of glycine in reducing CO_2 production from glucose-C^{14} without a reduction in total CO_2 production and the observation that glycine is metabolized lead to the postulation that glycine utilization may have a sparing effect on glycolysis in bovine spermatozoa. Obviously such an effect may not account for all of the benefit derived from glycine.

These studies are being extended to obtain additional information regarding the metabolism of glycine by bovine spermatozoa, particularly with regard to the nature of other possible intermediates and end-products.

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Table 1. Formation of labeled products from C^{14}-labeled glycine by bovine spermatozoa. Yields expressed per 10^9 cells for 2 hours.

Expt.	Product			
	CO_2		Formate (count/min)	Glyoxylate (count/min)
	μ mole	(count/min)		
No. 1				
4 μcurie glycine + formate	13	4240	2300	
No. 2				
2 μcurie glycine	28	2680		
2 μcurie glycine + glyoxylate	10	1700		1040

Table 2. Oxidation of glucose and glycine in suspensions of bovine spermatozoa in Ringer-phosphate buffer, *p*H 7.1. Results expressed per 10^9 cells for 2 hours.

Substrate	Respiratory CO_2	
	count/min	μmoles
Glycine-C^{14}	5295	32
Glycine-C^{14} + unlabeled glucose (0.01*M*)	4085	31
Glucose-C^{14}	7305	33
Glucose-C^{14} + unlabeled glycine (0.01*M*)	6935	30
Glucose-C^{14} + unlabeled glycine (0.1*M*)	6150	34

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References and Notes

1. A. Tyler and T. Y. Tanabe, *Proc. Soc. Exptl. Biol. Med.* 81, 367 (1952); I. G. White, *J. Biol. Sci.* 7, 379 (1954).
2. A. Tyler and Lord Rothschild, *Proc. Soc. Exptl. Biol. Med.* 76, 52 (1951); F. W. Lorenz and A. Tyler, *ibid.* 78, 57 (1951).
3. A. Roy and W. H. Bishop, *Nature* 174, 746 (1954); J. M. Rakes and O. T. Stallcup, *Science* 123, 224 (1955).
4. R. J. Flipse and J. O. Almquist, *J. Animal Sci.* 14, 1182 (1955).
5. Authorized for publication as a paper No. 2062 in the journal series of the Pennsylvania Agricultural Experiment Station. This work was aided by grants from the U.S. Atomic Energy Commission, contract No. AT(30-1)-1849, and the Pennsylvania State Association of Artificial Breeding Cooperatives.
6. F. X. Gassner and M. L. Hopwood, *Proc. Soc. Exptl. Biol. Med.* 81, 37 (1952); J. Tosic and A. Walton, *Biochem. J.* (*London*) 47, 199 (1950).
7. H. I. Nakada, B. Friedmann, S. Weinhouse, *J. Biol. Chem.* 216, 583 (1955).
8. P. E. Johnson, R. J. Flipse, J. O. Almquist, *J. Dairy Sci.* 39, 180 (1956).

14 May 1956

Maternal and Sexual Behavior Induced by Intracranial Chemical Stimulation

A technique permitting chemical or electric stimulation, or both, of restricted brain areas in unanesthetized rats, and electroencephalographic (EEG) recording from these areas, has been developed and found to be of value (*1*).

Implants are prepared as follows. Two Tygon-insulated copper or silver wires (0.1 mm in diameter) are baked along the outside of No. 22 hypodermic tubing extending from 2 to 9 mm below the base of a plastic holder (*2*). The wires lead from contact points on the holder and terminate at opposite sides of the end of the shaft as a bipolar stimulating-and-recording electrode. The implant shaft is permanently inserted in the brain while the anesthetized rat is held in a stereotaxic instrument. Four holes in the base of the holder permit rigid attachment to the skull with jeweler's screws.

Two or more days later, rats are placed in 3- by 3- by 2.5-ft boxes for stimulation testing. A small clip connects the implant to light overhead leads from a 0- to 12-v, 60 cy/sec stimulator, or to an EEG machine. The clip also contains a

No. 30 metal cannula that penetrates the implant shaft to the depth of the electrode tips or lower. Seven feet of PE 10 polyethylene tubing (0.024 in. in diameter) leads from the cannula to a microsyringe which can release a minimum of 0.0001 cm^3 of solution into the brain. All overhead leads are intertwined and spring-mounted, permitting repeated, controlled stimulation of a freely moving animal. Behavioral tests with a series of external stimulus objects are given before, during, and after chemical stimulation, and placebo solutions and nonhormonal neural excitants are used for control brain injections during initial tests or retests.

The technique is first being used to test whether there are "primary drive centers" under hormonal influence or control (*3*). Thus far, maternal and sexual behavior have been elicited from separate brain loci in a series of males during stimulation with sodium testosterone sulfate in 0.09-percent saline, and, subject to verification, a mixture of a pure salt of estrone and a suspension of progesterone has induced heat behavior in two females (*4*). Maternal behavior elicited during chemical stimulation includes nest building and a persistent retrieving and grooming of litters of young. All aspects of mating behavior have been induced or accentuated. Attendant high-drive states are suggested by an exaggerated speed, compulsiveness, and frequency of all overt responses during positive test periods.

Although individual animals respond positively for up to 4 test days, duplication of effect from animal to animal has imposed difficult problems. Of 130 male operates tested with the testosterone salt, five have shown complete maternal response, 14 have shown nesting behavior only, and six have shown exaggerated sexual response. Histological data suggest that locus of immediate action is a critical factor, with slight variation in placement leading to incomplete, confounded, or diffuse drive states, or negative results. Initial findings tentatively implicate the medial preoptic area in maternal behavior and the lateral preoptic area in sexual behavior.

A variety of effects have been noted during testosterone stimulation at adjacent loci. Those seen in five or more cases include respiratory changes, diffuse hyperactivation, long-lasting exploratory-like behavior, repetitive localized muscular response, digging, leaping, and seizures.

The following list includes other significant points of departure from chemical- or electric-stimulation data reported in the literature. Since positive test responses completely transcend control behavioral data, two single cases of possible theoretical significance are also briefly described.

1) Elicited behavior, whether specific or diffuse, commonly continues without decrement for more than 90 minutes following chemical stimulation.

2) An entire hierarchy of related responses can be brought to the threshold of activation, with adequate stimulus objects insuring integrated behavior.

3) A segment of a response hierarchy may occur alone. Excessive nest-building is often seen, and one aspect of the nesting pattern, "pick up paper and push under body," continued rapidly for more than 1 hour in three cases.

4) Specific behavior has occurred in the absence of appropriate external stimuli. One male continuously "retrieved" his tail when stimulated with testosterone and then repeatedly retrieved a female in heat. When pups and paper were supplied, however, the male built a nest and retrieved and groomed the young, neglecting the objects to which he previously reacted.

5) In one case, maternal and sexual drives were activated simultaneously. The testosterone-treated male reacted to stimuli related to each drive and to a degree never shown in control tests. Double activation was most convincingly illustrated when a female (not in heat) and newborn rat pups were presented. The male attempted copulation twice while a pup he was retrieving to a nest was still in his mouth. Shaft placement was adjacent to both areas previously implicated in sexual and maternal response.

All effects have followed injection of minute amounts of solution, containing from 0.003 to 0.05 mg of the testosterone salt. In this connection, it must be emphasized that the possibility remains that causative factors other than hormonal properties may be operating. Thus far, however, control testing with neural excitants, physiological saline, and electric stimulation has failed to produce or perpetuate these complex behavior patterns.

Initial EEG data are promising. Records from six testosterone-treated "maternal" or "nesting" males have shown single spiking lawfully spaced in a normal record rather than the general spiking seen after picrotoxin or metrazol injection. Selective chemical action seems probable. Also, testosterone-induced spiking occurs before, not during, elicited overt behavior. Correlation of EEG changes with brain stimulation and with elicited response presents technical problems but could become a powerful tool.

The early data suggest other implications and further applications.

1) A neurophysiological definition of drive seems within reach. The role of hormones in eliciting behavior should be clarified as well as the organization of neural circuits that mediate or integrate primary drives. Present data favor a "neural center" theory, but control studies are needed.

2) Responses analogous to symptoms of mental dysfunction often occur during chemical stimulation. These include "obsessive-compulsive acts," tics, diffuse excitation, and states of hypo- and hypersensitivity to sensory stimuli. Further work may establish tie-ins between shifts in chemical balance in the central nervous system and certain forms of mental dysfunction.

3) Males having no adult contact with females, young, or paper have responded to chemical stimulation with integrated maternal behavior on the first trial. The data are pertinent to the problem of whether innate, centrally organized sensory-motor connections exist for complex response systems.

4) Testosterone has ostensibly elicited both sexual and maternal patterns. The findings may reflect multiple properties for the hormone. Limited progesterone-like activity has been proposed for the androgens by Selye, and progesterone has been linked to maternal response.

5) Chemical stimulation has elicited long-lasting, integrated behavior that was free of lapse or interference. The data strongly suggest selective chemical action within the central nervous system. Further work may demonstrate that differential sensitivity to specific physiological change by functionally organized areas of the nervous system is a basic principle of neural function.

In summary, integrated, long-lasting drive states have been induced by direct chemical stimulation of brain loci. Further work with techniques of this type could well lead to breakthroughs in the study of pharmaceutical action, brain organization and function, and the dynamics of behavior.

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References and Notes

1. I initiated the work as a public health postdoctoral fellow at McGill University with D. O. Hebb as sponsor. Work continues at the University of Wisconsin during the second fellowship year with H. F. Harlow as sponsor.
2. The Lucite holder is identical with that described by J. Olds and P. Milner, *J. Comp. Physiol. and Psychol.* 47, 419 (1954).
3. For example, F. A. Beach, *Psychosomat. Med.* 4, 173 (1942).
4. Hormone salts supplied by Ayerst, McKenna, and Harrison, Ltd., Montreal, Canada.

17 May 1956

A practical man is one who practices the errors of his forefathers.—BENJAMIN DISRAELI.

Book Reviews

Learning across Cultures. A study of Germans visiting America. Jeanne Watson and Ronald Lippitt. Institute for Social Research, Univ. of Michigan, Ann Arbor, 1955. x + 205 pp. $3.

A concomitant of the rapid expansion of international exchange programs in the decade since World War II—more than 40,000 foreign nationals now annually visit the United States for broadly educational purposes—has been an upsurge of interest on the part of both administrators and social scientists in assessing the effects of cross-cultural educational experience. Understandably, administrators of exchange programs (and the donors of the funds that support them) have been concerned with evaluating their success. Social scientists, in addressing themselves to this practical question, have, for their part, tapped a challenging area of inquiry that lies at the grassroots level of research on international relations. That this can be a happy marriage of interests is abundantly demonstrated in the volume under review.

The present study reports the results of intensive research on the experiences of 29 young German men and women brought to this country in three separate groups during the period 1949 to 1951 under the auspices of the U.S. State Department. Their visits, which lasted either 6 or 12 months, were based at the University of Michigan and provided a combination of academic training, internship experience, and field trips. Although their sample is thus restricted, the author's aim is to go beyond the limitations of the particular population studied to a more general understanding of cross-cultural education. They are notably successful in fulfilling their intent.

The research focuses on the study of stability and change in the attitudes and general point of view of the visitors and on the analysis of the process whereby learning occurs across cultures. The primary data relevant to these two major topics were derived from a series of three lengthy structured interviews with each subject, the first shortly after his arrival, the second just prior to his departure, and the third six months after his return to Germany. Supplementary information was obtained from sentence completion tests and from the observations of the American participants in the training and research program. As a check, comparable data were also obtained from two matched American control groups.

As distinguished from many similar studies, the approach is analytic and interpretive rather than simply descriptive. Herein lies the book's greatest value for social scientist and practitioner alike. The insights gained from the research are applicable to a broad range of exchange programs and will be welcomed by all who are responsible for the administration of cross-cultural education. Nor do the authors display the social scientist's usual coyness about making practical suggestions; recommendations are liberally scattered throughout the text, and a separate section is devoted to "Directions of program improvement." Moreover, in examining the psychological dynamics underlying the reactions of the sojourner in a strange and sometimes hostile environment, the book contributes as well to the main stream of social-science research. The authors both draw from and add significantly to such areas as the psychology of the self and learning and reference group theory.

Finally, one notes that the book is well designed for its intended dual audience. The technical apparatus, including examples of instruments used in the research and an array of statistical tables, is included in an appendix, and the unencumbered text is written in a fluent and eminently readable style. Thus, with respect to both form and substance, here is a book that deserves to be widely read.

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The Meaning of Relativity. Albert Einstein. Princeton University Press, Princeton, ed. 5, 1955. 166 pp. + index. $3.75.

Five years after the appearance of his comprehensive paper on general relativity, in May 1921, Albert Einstein delivered a set of four lectures at Princeton University, which were subsequently published under the title *The Meaning of Relativity*. Except for a few reprintings, no new edition came forth until 1945, when Einstein added an appendix concerned with the cosmological problem. For the third edition, 1950, he added an "Appendix II," "Generalization of gravitation theory," which was brought up to date for the fourth edition, dated 1953, through the addition of the concept of the "lambda transformation" and by the discussion of what Einstein called the "strength" of equation systems. The present, fifth edition carries Appendix II in a completely revised form, under the title "Relativistic theory of the non-symmetric field"; a very brief prefatory note by Einstein is dated December 1954.

Except for a paper that also appeared posthumously, together with Bruria Kaufman, the fifth edition of *The Meaning of Relativity* is Einstein's last work. Aside from Appendix II, it appears to be an unchanged reproduction of the earlier editions, including the discussion concerning the embarrassing youth of the universe (which, at the time of the writing of the second edition, appeared to be less than the age of the oldest known rock formations on Earth). This discussion has now become unnecessary because of the upward revision of the age of the universe in recent years made by the astronomers.

It is not necessary to praise at length Einstein's mastery of clear exposition, which is known to anyone who has read some of his scientific writings. Inevitably, some of the brilliance of his style is lost in translation, in spite of the excellent work of Adams (for the original lectures), Straus (for the first appendix), and S. Bargmann (for the second appendix). I should like to comment briefly on some technical points.

To deprive the symmetric character of an affine connection of its invariant character and thereby meet one of the most persistent criticisms of the nonsymmetric theory, Einstein had devised a new invariant transformation group, the so-called λ-transformation, which was already described in the fourth edition. Originally, this additional transformation of the affine connection depended on an arbitrary vector field. Later, Einstein modified the group by restricting this vector field to be a gradient field, and that is how the λ-transformation appears in the fifth edition. The new transformation group is isomorphic with the gage group of electrodynamics. As a result, the identification of charge-current density and electromagnetic field strength in the nonsymmetric theory is unique.

For choosing the variational principle from which the field equations of the nonsymmetric theory are to be derived, Einstein establishes three requirements,

(i) that the theory be invariant with respect to coordinate and λ-transformations, (ii) that it be transposition-invariant (that is, that the equations read from right to left are equivalent to those read from left to right), and (iii) that the equations have the greatest possible "strength." The "strength" of a system of equations is a new concept introduced by Einstein, which measures the extent to which the equations determine the field variables. In contrast to the concept of a Cauchy problem, which requires the singling out of a direction of continuation, the definition of strength treats all four coordinates on the same footing.

We do not yet know whether Einstein's nonsymmetric field theory, or any other "unified field theory" proposed so far, will have a place in the physical theories of the future. Very possibly the time is not ripe for progress in this field. But anyone who sincerely believes in the organic unity of nature will be impressed by the program of unified field theory as an important approach toward the recognition and understanding of that unity. The last book by Albert Einstein represents an extremely significant contribution to this quest.

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L'Evolution de la Lithosphere. I, Pétrogenèse. Henri Termier and Genevieve Termier. Masson, Paris, 1956. 654 pp. Illus. Cloth, F. 8800; paper, F. 8000.

This is the second volume of the *Traité de Géologie* by these authors. The first part was published in 1952, and two more volumes are promised. Petrogenesis is divided into two parts: "Generalities," of 9 chapters (264 pp.), and "Problems of petrogenesis," 13 chapters (335 pp.)

Starting with a brief resumé on the constitution of matter (including a periodic table), the authors consider the gaseous material from which solids are supposed to have condensed. Here the tectites, iron, stone-iron, and lastly the stone meteorites are discussed. The ideas of Urey on the origin of the earth, the build-up of the primitive atmosphere, the birth of water and the accumulation of the oceans, and the beginning of life, are also discussed. These first three chapters are a sort of introductory containing mostly theory. In chapter 4 the lithosphere is introduced, and the authors consider the effect on the crust of cosmic and ultraviolet rays and how photosynthesis and oxygen reduction produce energy. Terrestrial magnetism and gravitation lead naturally to a discussion of isostasity with stable and unstable areas, buckling and orogenies. These, along with thermodynamics, give us regional metamorphism, volcanism, and the formation of granite.

Starting with Laue's work in 1912, the internal structure of crystals has been under investigation, giving us more and more insight into molecules and atoms. The authors state that the "tetra coordinates of silicon is one of the fundamental characteristics of the Lithosphere," and that the silica and aluminum make up the upper part of the lithosphere, the sial of E. Suess. The classification of Green of (i) metals or conductors, (ii) the sulfurs or nonconductors, (iii) the OH groups, (iv) the hydrogene, (v) the silicates, and (vi) natural gases, is given. In chapter 6 the displacement and diffusion of matter in the lithosphere by various means, along with the various imperfections of crystals, are considered.

Chapter 7 deals with minerals from the glasses to the rare earths. Chapter 8 discusses geochemistry and considers the organic as well as the usual inorganic side of earth chemistry. Carbon comes in for careful consideration, especially the isotopes C^{12}, C^{13} and C^{11}, as well as C^{14}. Chapter 9 gives the age of the universe as about 6000 million years and the age of the earth as about 3500 million years, considered from some nine different radioactive approaches.

Under "Problems of petrogenesis," chapter 1 gives us the interinfluence of the terrestrial and meteoritic processes of the geologic evolution of the crust. The zones of weakness, both parallel and at angles to the directions of orogenesis (chapter 2), are followed (in chapter 3) by a synopsis giving succession of the phenomena with the tectonic phases and geosynclinal phases following through stages of deformation, sedimentary deposits, volcanism, metasomatism, petrogenesis, and occurrence. These chapters serve to localize the rocks in time and space.

After reviewing the mode of occurrence (chapter 4), the chemical classification, mineralogical occurrence, chemical-mineralogical classification, the C.I.P.W. classification as modified by Lacroix, Niggle's classification, and statistical methods, the authors give a simplified genetic classification of (i) rocks supersaturated with silica, (ii) rocks saturated with silica, (iii) rocks not saturated with silica, but with feldspathoids, (iv) ultrabasis rocks, and (v) charnockites, anorthosites and lamprophyres. Chapter 5 examines the magmas from various points of view and includes a table showing a series of continuous and a series of discontinuous changes supposed to go on in the liquid material. Next, in chapter 6, volatile, fluid parts, gases, waters, and mineralizing fractions lead naturally to volcanism. In chapter 7 some seven types of volcanic activity are listed. The contribution of geosynclines to the sima occupy chapter 8.

Chapter 9 is a long one and deals with metamorphism, pneumatolytic metasomatism, and hydrothermal metasomatism, running the gauntlet from granite pegmatites to evaporates. Here are introduced the authors' idea of "fronts," sorts of zones of combat between different materials in the crust. The numerous ideas are documented by numerous examples largely from the authors' experiences, but the vast literature is drawn on to bolster their ideas. The problems of granite fill chapters 10 and 11. Finally, chapter 12 discusses convergent rocks (in the biologic sense of convergent), and the last chapter tells of the aberrant rocks.

Throughout the book, the authors consider the importance of the atomic structure of the minerals and the crystal fabric. The influence of gravitation on crustal material is pointed out, and the authors consider metasomatism of the first order in identification and transformation of petrographic types. They favor the progressive differentiation of the sial at the expense of the sima and feel that some petrographic types have a plural or convergent origin.

In all, it is a very detailed study; each chapter, and even some subdivisions, has its own bibliography, sometimes running well over 100 titles. The amount of material covered makes it slow reading, but the book is well worth the effort. The figures and tables are clear and effective. The plates are well chosen and are placed at appropriate places in the text. The style is more literary than that of most geologic textbooks, and it is clear and very much to the point. Certainly all petrographers, mineralogists, and geologists should study it, for there is much to be derived from it, and it is a fitting volume of *Traité de Géologie*.

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Geometrical Optics. L. C. Martin. Philosophical Library, New York, 1956. 215 pp. $7.50.

This is an interesting and well-written treatise covering the elementary problems of geometrical optics, with the addition of some short chapters on diffraction and photometry.

In the first chapter, "The laws of geometrical optics," the author discusses the refraction and reflection laws and basic concepts, such as tangential and sagittal focus, real and virtual images, and the Smith-Helmholtz relation coordinating transverse and angular magnification.

The second chapter covers the first-

order approximation theory—that is, paraxial optics. Unfortunately, the author, like most textbook writers, considers it as a special case of a collineation. (This concept was shown by Allvar Gullstrand in 1907 to be in contradiction to optical laws, especially the law of Malus.) The author develops in this chapter the well-known formulas for the position of object and image in thin lenses, thick lenses, and general optical systems.

The third chapter, "Optical instruments," deals with the basic types of instruments, their paraxial data, and the chromatic axial aberrations (longitudinal and lateral).

Chapter 4 deals with the wave nature of light, elementary problems of diffraction, and the resolution of optical instruments. The optical sine theorem of Abbe is also discussed.

Chapter 5, "The observation and recording of images," discusses the elementary properties of the human eye and the use of spectacles, whereas Chapter 6, "Photometry," discusses problems of illumination, the radiation diagram of light sources, and photometry.

The last chapter discusses the third-order aberration figures.

Numerous short appendixes deal with the vectorial form of the refraction law, with depth of focus, with some dispersion formulas, and with the derivation of Euler's formulas for the light path in nonhomogeneous media.

Examples are given at the end of each chapter. The book is clearly written and is a very good elementary introduction to the subject.

M. HERZBERGER

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The Systematic Identification of Organic Compounds. A laboratory manual. Ralph L. Shriner, Reynold C. Fuson, and David Y. Curtin. Wiley, New York; Chapman & Hall, London, ed. 4, 1956. 426 pp. $6.

The excellent features of this popular laboratory manual are well known, and the present review will be concerned only with a comparison of the third (1948) and fourth editions.

Perhaps the most conspicuous innovation is the introduction of a chapter (8) on "The use of spectroscopic methods for functional group determination." The chapter is concisely written and at the level of the student for whom the textbook is designed. Six classification tests (Chapter 2), of doubtful value, have been omitted. The suggestions for the examination of the literature have been improved, and ample warning is given concerning the reliability of certain formula indices. Some parts of Chapter 6 ("The solubility classes") have been largely rewritten. The discussion on "Generalizations from solubility data" has been simplified and placed on a more rational basis, even within the present limitations of solubility theory. A much needed section on "Electronic effects on acidity and basicity" is included. The treatment of amphoteric compounds remains unsatisfactory.

Although Chapter 7 ("Application of classifications tests") retains its general aspect, it is evident that considerable attention has been given to the chemical details of the classification tests (note experiment 2). The new approach is best illustrated in experiment 21 (silver nitrite solution test), in which a rather comprehensive discussion of the theory of replacement reactions is presented. No significant change has been introduced in the 15 sets of problems. Some of the more abstruse examples were omitted, but no new problems were added. This textbook has gained considerably in its new edition.

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Books Reviewed in The Scientific Monthly, August

Science and the Course of History, P. Jordan, translated by R. Manheim (Yale University Press; Oxford University Press). Reviewed by I. B. Cohen.

Celebrated American Caves, C. E. Mohr and H. N. Sloane (Rutgers University Press).

Viral and Rickettsial Diseases of the Skin, Eye, and Mucous Membranes of Man, H. Blank and G. Rake (Little, Brown). Reviewed by H. Koprowski.

The Navajos, R. M. Underhill (University of Oklahoma Press). Reviewed by D. F. Aberle.

Chemical Calculations, H. V. Anderson (McGraw-Hill). Reviewed by F. J. Llewellyn.

The Thirteen Books of Euclid's Elements, translated from the text of Heiberg with introduction and commentary by T. L. Heath (Dover).

Atlas of Paleogeographic Maps of North America, C. Schuchert (Wiley; Chapman & Hall). Reviewed by E. W. Berry.

Geology: Principles and Processes, W. H. Emmons, G. A. Thiel, C. R. Stauffer, and I. S. Allison (McGraw-Hill). Reviewed by H. R. Gault.

New Books

Basic Chemistry of Textile Colouring and Finishing. 191 pp. $6. *Basic Chemistry of Textile Preparation.* 197 pp. $6. S. R. Cockett and K. A. Hilton. Philosophical Library, New York, 1956.

The Chemistry and Mode of Action of Plant Growth Substances. Proceedings of a symposium held at Wye College (University of London), July, 1955. R. L. Wain and F. Wightman, Eds. Academic Press, New York; Butterworths, London, 1956. 312 pp. $9.50.

The Fighting Cheyennes. George Bird Grinnell. University of Oklahoma Press, Norman, 1956. 453 pp. $5.

The Classification of Lower Organisms. Herbert F. Copeland. Pacific Books, Palo Alto, Calif., 1956. 302 pp. $7.50.

A Handbook for the Identification of Insects of Medical Importance. John Smart. Chapters on fleas by Karl Jordan and on arachnids by R. J. Whittick. British Museum (Natural History), London, ed. 3, 1956. 303 pp. £2.

Flow of Gases through Porous Media. P. C. Carman. Academic Press, New York; Butterworths, London, 1956. 182 pp. $6.

A Dictionary of English Domestic Architecture. A. L. Osborne. Philosophical Library, New York, 1956. 111 pp. $6.

Asymptotic Expansions. A. Erdélyi. Dover, New York, 1956. 108 pp. Paper, $1.35.

An Essay on the Foundations of Geometry. Bertrand A. W. Russell. Dover, New York, 1956. 201 pp. Paper, $1.50.

Experiment and Theory in Physics. Max Born. Dover, New York, 1956. 43 pp. Paper, $0.60.

Electrical Interference. A. P. Hale. Philosophical Library, New York, 1956. 122 pp. $4.75.

Annual Review of Plant Physiology. vol. 7. Lawrence R. Blinks, Ed. Annual Reviews, Stanford, Calif., 1956. 456 pp. $7.

Illustrations of the Huttonian Theory of the Earth. John Playfair. Facsimile reprint, with an introduction by George W. White, of 1802 edition published by Cadell and Davies, London and William Creech, Edinburgh. University of Illinois Press, Urbana, 1956. 528 pp. $4.50.

Mechanical Vibrations. J. P. Den Hartog. McGraw-Hill, New York, ed. 4, 1956. 436 pp. $9.

Hydrodynamics. Hugh L. Dryden, Francis D. Murnaghan, H. Bateman. Dover, New York, 1956. 634 pp. Paper, $2.50.

Chromosome Botany. C. D. Darlington. Allen & Unwin, London, 1956 (order from Macmillan, New York). 186 pp. $2.75.

Health for the American People, a Symposium. Presented 21 Nov. 1955. Massachusetts Memorial Hospitals Centennial Celebration. Little, Brown, Boston, 1956. 105 pp. $1.

Some Clinical Applications of Electroneurophysiology, Especially Electrodiagnosis and Electromyography. Sidney Licht, Ed. Elizabeth Licht, New Haven, Conn., 1956. 272 pp. $10.

Secret Enemy. The story of a disease. James Cleugh. Thomas Yoseloff, New York, 1956. 273 pp. $5.

J. C. Poggendorff Biographisch-Literarisches Handworterbuch der Exakten Naturwissenschaften. vol. VIIa (two sections), pt. 1, A–E. Rudolph Zaunick and Hans Salie. Akademie, Berlin, 1955. 256 pp. DM. 12 per section.

A Field Guide to the Ferns and Their Related Families of Northeastern and Central North America with a Section on Species Also Found in the British Isles and Western Europe. Boughton Cobb. Houghton Mifflin, Boston, 1956. 281 pp. $3.75.

Blakiston's New Gould Medical Dictionary. Normand L. Hoerr and Arthur Osol, Eds. Blakiston Div., McGraw-Hill, New York, ed. 2, 1956. 1463 pp. $11.50.

Introduction to Microfossils. Daniel J. Jones. Harper, New York, 1956. 406 pp. $6.50.

Principles of Fungicidal Action. James Horsfall. Frans Verdoorn, Ed. Chronica Botanica, Waltham, Mass., 1956. 279 pp. $6.50.

The Historical Background of Chemistry. Henry M. Leicester. Wiley, New York; Chapman & Hall, London, 1956. 260 pp. $6.

Principles of Color Television. Hazeltine Laboratories staff. Knox McIlwain and Charles E. Dean, Eds. Wiley, New York; Chapman & Hall, London, 1956. 595 pp. $13.

Patterns of Mothering. Maternal influence during infancy. Sylvia Brody. International Universities Press, New York, 1956. 446 pp. $7.50.

Illustrated Guide to Trees and Shrubs. A handbook of the woody plants of the Northeastern United States and adjacent regions. Arthur H. Graves. Harper, New York, rev. ed., 1956. 271 pp. $6.

General Chemistry. John A. Timm. McGraw-Hill, New York, ed. 3, 1956. 636 pp. $6.

Hormones and the Aging Process. Proceedings of a conference held at Arden House, Harriman, N.Y., 1955. Earl T. Engle and Gregory Pincus, Eds. Academic Press, New York, 1956. 323 pp. $8.50.

The American Arbacia and Other Sea Urchins. Ethel B. Harvey. Princeton University Press, Princeton, N.J., 1956. 298 pp. $6.

Physics and Mathematics. vol. I of *Progress in Nuclear Energy.* R. A. Charpie, J. Horowitz, D. J. Hughes, D. J. Littler, Eds. McGraw-Hill, New York; Pergamon, London, 1956. 398 pp. $12.

The Structure of Turbulent Shear Flow. A. A. Townsend. Cambridge University Press, Cambridge, 1956. 315 pp. $7.50.

Elementary Nuclear Theory. Hans A. Bethe and John Morrison. Wiley, New York; Chapman & Hall, London, 1956. 274 pp. $6.25.

The Dynamics of Aging. Ethel S. Smith. Norton, New York, 1956. 191 pp. $2.95.

Doctor Jimek, I Presume. Bernhard Grzimek. Trans. by R. H. Stevens. Norton, New York, 1956. 247 pp. $3.75.

Symposium on Monte Carlo Methods. Held 16–17 March 1954 at the University of Florida; conducted by the Statistical Laboratory; sponsored by Wright Air Development Command. Herbert A. Meyer, Ed. Wiley, New York; Chapman & Hall, London, 1956. 382 pp. $7.50.

Child Development. Elizabeth B. Hurlock. McGraw-Hill, New York, ed. 3, 1956. 703 pp. $6.

A Synopsis of Contemporary Psychiatry. George A. Ulett and D. Wells Goodrich. Mosby, St. Louis, 1956. 243 pp. $5.25.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

The Role of Limnora Tripunctata in Promoting Early Failure of Creosoted Piling. Tech. Memo. M-109. H. Hochman, H. Vind, T. Roe, Jr., J. Muraoka, J. Casey. U.S. Naval Civil Engineering Research and Evaluation Laboratory, Port Hueneme, Calif., 1956. 43 pp.

Two New Fossil Thrips from Baltic Amber (Thysanoptera; Terebrantia). Fieldiana: Zoology, vol. 34, No. 40. Lewis J. Stannard, Jr. 8 pp. $0.20. *Fauna of the Vale and Choza: 11. Lysorophus: Vale and Choza. Diplocaulus, Cacops and Eryopidae Choza.* Fieldiana: Geology, vol. 10, No. 25. Everett C. Olson. 10 pp. $0.20. *Fauna of the Vale and Choza: 12. A New Trematopsid Amphibian from the Vale Formation.* Fieldiana: Geology, vol. 10, No. 26. Everett C. Olson. 6 pp. $0.15. *Fauna of the Vale and Choza: 13. Diadectes, Xenacanthus, and Specimens of Uncertain Affinities.* Fieldiana: Geology, vol. 10, No. 27. Everett C. Olson. 6 pp. $0.15. Chicago Natural History Museum, Chicago, Ill., 1956.

Annual Epidemiological and Vital Statistics, 1953. pt. I, *Vital Statistics and Causes of Death*; pt. II, *Cases of and Deaths from Notifiable Diseases.* 571 pp. $10. *Malaria Conference for the Western Pacific and South-East Asia Regions* (Second Asian Malaria Conference). Baguio, Philippines, 15–24 November 1954. WHO Tech. Rept. Ser. No. 103. 44 pp. $0.30. World Health Organization, Geneva, 1956.

The Population Council, Inc., Reports of the Executive Officers for the Period 5 November 1952 to 31 December 1955. The Council, New York 17, 1956. 40 pp.

Reports on the Productive Uses of Nuclear Energy. The Outlook for Nuclear Power in Japan. Michael Sapir and Sam J. Van Hyning. National Planning Assoc. Washington, D.C., 1956. 175 pp. $3.

The Ford Foundation Annual Report, 1 October 1954 to 30 September 1955. The Foundation, New York, 1956. 170 pp.

An Evaluation of the Newer Psychopharmacologic Agents and Their Role in Current Psychiatric Practice. Psychiatric Research Repts. No. 4. Jacques S. Gottlieb, Consultant Editor. American Psychiatric Assoc., Washington, D.C., 1956. 129 pp. $2.

Radio and Television Bibliography. Bull. 1956, No. 2. Gertrude G. Broderick. Office of Education, Washington 25, 1956 (order from Supt. of Documents, GPO, Washington 25). 46 pp. $0.25.

European Organization for Nuclear Research, First Annual Report. CERN, Case postale 25, Geneva 15, 1956. 65 pp.

Centrocneminae, a New Sub-Family of the Reduviidae (Hemiptera-Heteroptera). Bulletin of entomology, vol. 4, No. 6. N. C. E. Miller. British Museum (Natural History), London, 1956. 67 pp. 15s.

Atlas of Exfoliative Cytology, Supplement 1. George N. Papanicolaou. Published by Harvard University Press, Cambridge, Mass., 1956, for the Commonwealth Fund. 40 pp.

Proceedings of the Pan Indian Ocean Science Congress. Officers, Constitution, Congress Membership, Minutes. 32 pp. sect. A, Physical Sciences. 88 pp. sect. B and D, Biological and Agricultural Sciences. pts. 1 and 2. 83 pp. and 64 pp. sect. C, Geology. 83 pp. sect. E, Economics, Education, and Social Sciences. 50 pp. sect. F, Geography and Oceanography. 87 pp. sect. G, Human Ecology. 74 pp. Pan Indian Ocean Science Congress, Perth, Western Australia, 1954.

The Fund for the Republic, a Report on Three Years' Work. 31 May, 1956. The Fund for the Republic, New York 17, 1956. 100 pp.

Some Acclimatizing Responses of Man to Prolonged Cold Exposure. Robert W. Elsner. 1955. 38 pp. *The Application of the Photoelectric Plethysmograph to the Nasal Septum.* The first of a series of reports on vascular responses of the nasal mucosa. Alrick B. Hertzman and Darrell L. Davis. 1955. 17 pp. *Further Study of Alaskan Schistosomes.* Reinard Harkema. 1955. 15 pp. *Regional Heat Loss by Temperature Gradient Calorimetry.* A. C. Young, L. D. Carlson, H. L. Burns. 1955. 13 pp. *Nervous Control of Shivering.* III, *A Shivering Pathway in the Brain Stem and Spinal Cord.* Lucy Birzis and Allan Hemingway. 1955. 12 pp. *Nervous Control of Shivering.* IV, *The Effect of Hypoxia on Shivering.* Allan Hemingway and Lucy Birzis. 1956. 10 pp. *Psychosocial and Psychophysiologic Studies of Tuberculosis.* Thomas H. Holmes, Norman G. Hawkins, Edmund R. Clarke, Jr., Joy R. Joffe, Charles E. Bowerman. 1956. 23 pp. Arctic Aeromedical Laboratory, Ladd Air Force Base, Alaska.

Physiological Studies on Infantrymen in Combat. University of California Publications in Physiology, vol. 10, No. 1. Nello Pace, Frederick L. Schaffer, Fred Elmadjian, David Minard, Stanley W. Davis, John H. Kilbuck, Elaine L. Walker, Muriel E. Johnston, Algird Zilinsky, Ralph W. Gerard, Peter H. Forsham, Jean G. Taylor. University of California Press, Berkeley, 1956. 47 pp. $1.25.

The Rock-Shelter of La Colombiere. Archeological and geological investigations of an Upper Perigordian Site Near Poncin (Ain). American School of Prehistoric Research, Peabody Museum, Harvard University, Bulletin No. 19. Hallam L. Movius, Jr. and Sheldon Judson. With a report on a fauna by Henri Gauthier. French résumé by Francois H. Bordes. Hugh Hencken, Ed. Peabody Museum, Cambridge, Mass., 1956. 176 pp. $4.85.

Oceanographic Survey of the Gulf of Mexico. Investigation of shoreline-like features in the Galveston Bay Region, Texas. A&M project 24. Vernon J. Henry. 76 pp. $2. *Principles of Laboratory Temperature Control. Electronic Relays. Thermistor Operated Temperature Control.* A&M project 24. Charles M. Proctor. 43 pp. $1. A & M College of Texas, Department of Oceanography, College Station.

East Malling Research Station, Near Maidstone, Kent, Annual Report, 1955. 1 Oct. 1954–30 Sept. 1955. Kent Incorporated Society for Promoting Experiments in Horticulture, Kent, England, 1956. 162 pp. $2.

Meetings and Societies

Theoretical Geophysics

A conference on theoretical geophysics was held at the National Science Foundation in Washington, D.C., 1–3 Feb., jointly sponsored by the National Science Foundation and the Carnegie Institution of Washington. The steering committee of the conference appointed by the National Science Foundation included John von Neumann, chairman, E. H. Vestine, deputy chairman, L. V. Berkner, J. Kaplan, H. K. Stephenson, NSF liaison representative, and J. Charney, secretary. More than 100 participants were invited because of their interest in the use of theoretical and mathematical approaches in the solution of geophysical problems, mainly in meteorology, oceanography, hydromagnetism, geomagnetism, aurora, cosmic rays, ionospheric physics, atmospheric electricity, geochemistry, seismology, gravity and geodesy, tectonophysics, and origin of the earth.

H. Stommel began first session with a discussion of the general circulation of the oceans. The importance of wind in driving the ocean is clear, but many effects are not well understood. J. Charney remarked that in recent years widespread observing stations and large computing machines have provided at least a crude cross section of the general circulation of the atmosphere. Fultz spoke on model experiments, illustrating hydrodynamics for bodies in rotation, when the primary driving forces are thermal, and discussed these in relation to upper air waves and cyclones. V. P. Starr noted that the nonzonal motions of the westerly trade winds are now known to provide a primary mechanism for energy transfer spatially.

W. M. Elsasser observed that progress in other fields has opened up new vistas in geophysics. Convection in the earth's core, together with the Coriolis force, Elsasser and Parker have shown, can yield a dynamo producing the geomagnetic field. Chandrasekhar discussed time constants of the geomagnetic field in relation to the dynamo theory of its origin and to a possible periodic reversal in field at intervals of about 250,000 years. Gallet gave a paper in which he discussed the estimation of the temperatures near 300 kilometers, using radio astronomy techniques and the steady background of galactic radio noise as well as temperature-dependent estimates of the collision rate between ions and electrons.

During the second session, Chapman considered that heat from the solar corona at a temperature of 10^6 to 2×10^6°K would fall off as the two-seventh power of the distance from the sun. Near the earth this would give a temperature of about 225,000°K, providing a downward flux of energy into the earth's atmosphere. Chapman also indicated the need for rocket observations in determining heights of electric currents in the ionosphere, and whether currents are in the space beyond. N. C. Gerson discussed the forces that affect winds in the upper atmosphere, and in particular effects of gravity, pressure differences, Coriolis force, forces from crossed electric and magnetic fields, and transients.

W. Bennett showed beautiful motion pictures of streams flowing in Störmer orbits, around a magnetized sphere. A most interesting feature was the evidence for large numbers of particles crossing into a low-latitude closed or trapped region, by escape across a small forbidden region. Gunn and Byers showed that the sizes of raindrops and their formation depend upon nuclei and the electric charges they acquire. S. E. Forbush reviewed results obtained by application of statistical theory to cosmic-ray time series. There was derived a pronounced inverse year to year dependence of cosmic-ray intensity, and its variability, upon sunspot number. During magnetic storms there are often periodic decreases in cosmic-ray intensity.

J. A. Simpson described variations in neutron counts with latitude and longitude in equatorial regions. The terrestrial dipole as seen from several earth radii above the earth's surface does not seem to agree with that obtained from magnetic measurements at the earth's surface. E. H. Vestine stated that dynamical theory served to explain fluctuations in the length of the day in terms of changes in the rate of rotation of the central core measured from geomagnetism. A theoretical project designed to provide new estimates of electric conductivity of the upper mantle was proposed.

A. G. McNish reported on changes in F-region height associated with geomagnetic variations at the equator. He also discussed the importance of understanding the formation of the ionospheric layers for purposes of predicting radio propagation conditions. Oliver Wulf described results found by S. Nicholson and himself showing the presence of a universal wave in geomagnetic activity. J. Balsley discussed geologic and geomagnetic interpretations of rock magnetism. Magnetic reversals in rocks in adjacent strata might not mean reversals of the geomagnetic field in times past but sometimes seem to be associated with chemical make-up.

The morning period of the second day was devoted mainly to the theoretical aspects of problems of the earth's interior. F. Press demonstrated a phase-velocity method of estimating the average depth to the Mohorovičić discontinuity at the base of the earth's crust. Under the coastal mountains the depth to this discontinuity is about 35 kilometers, whereas under the high Sierras the depth is about 50 kilometers. He gave inferences from the phase velocities of seismic waves traveling between the Mohorovičić discontinuity and the earth's surface that suggested depths of the continental caps at about 35 kilometers or so. In ocean areas this discontinuity is at a considerably smaller depth.

Maurice Ewing discussed transverse or G-waves of very long periods which circumnagivate the upper levels of the earth. The absence of high-frequency S or shear waves might be explained if there are molten "bubbles" 10 to 50 kilometers in diameter reducing the amplitude of high-frequency shear waves. John Verhoogen said that, from surface measurements of the earth, one cannot tell whether it is heating or cooling, but the mantle down to about 2900-kilometer depth is usually below its melting point. Heiskanen discussed the size and shape of the earth. He mentioned the use of gravitational methods, the geoid and its shape, and inferences from gravitational anomalies.

Yoder introduced the subject of the thermodynamics of rock-forming processes. Discrepancies between predicted chemical activity and observation may be as great as by a factor 2. In fact, the important changes in composition with pressure and temperature cannot be predicted with present theory. Birch and Gutenberg have tried to identify the Mohorovičić discontinuity near 30 kilometers with a chemical phase transition, and MacDonald suggested that feldspar would be likely to undergo such a change at this depth. The change is from feldspar to a garnet.

During the afternoon session of 2 Feb., experimental papers on dating earth materials were given by Aldrich and by Suess. Aldrich said that many materials can now be dated with considerable confidence using isotope ratios Sr^{87}/Rb^{87}

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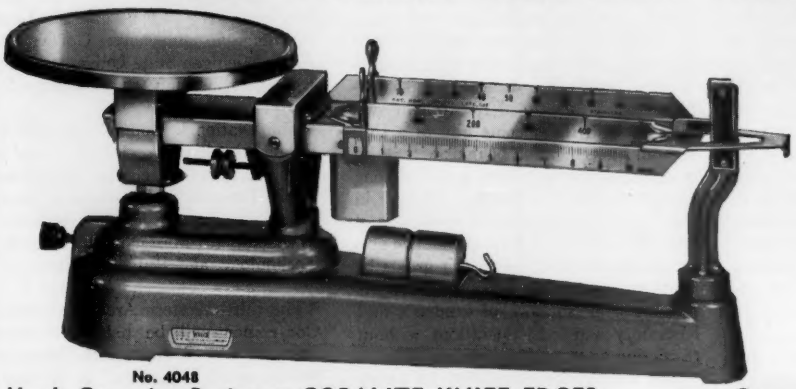

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and A^{40}/K^{40} for micas. Suess dated the various Ice Age deposits using C^{14} techniques. Dated examples were 8500, 12,000, 15,000, or 23,000 years ago.

Joseph Kaplan then described the International Geophysical Year program. He stated that the idea for an institute of theoretical geophysics arose naturally in early discussions of the IGY venture. Chapman and Berkner noted that the new and rich observational material of the IGY would afford opportunities for theoretical study in many countries for a long time. Helmut Landsberg staggered almost everybody by reporting that there are 300 million punch cards covering recent Weather Bureau data, and that these are added to at the rate of 60,000 or so a day. Pekeris and Slichter emphasized the need for improved theories of earth and atmospheric tides and oscillations and theoretical seismology, using advantages gained from electronic computers in this work.

A number of actions were taken by the conference unanimously. Each institution with a program in scientific geophysics was urged to intensify its activities in theoretical geophysics. It was agreed that there is now a need for at least one major institute that may devote its primary attention to the theoretical and mathematical aspects of geophysics, the coverage of which should be broad and not restricted to certain branches. The institute should be associated with, or be an integral part of, a university. Several universities indicated that they would plan to provide their own theoretical groups whether or not they were invited to provide a home for a new institute.

The conference recommended that substantial grants be made during the next 3 to 5 years to institutions that have outstanding records of accomplishment in training advanced students in experimental and theoretical research in geophysics, with the specific aim of a substantial intensification of their activity in scientific geophysics over a period long enough for them to develop strength in their permanent program of research and training in this field. The conference also recommended that nonproject grants be made to productive institutions for the training and support of students and laboratory and field operations without restriction as to problem or project.

The conference completed its heavy load of scientific study and work in a spirit of friendly and effective cooperation unusual for so large and assorted a gathering.

E. H. VESTINE
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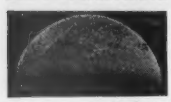

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Meeting Notes

■ The University of Michigan's ninth annual conference on aging, which took place in July, was attended by more than 700 persons from this country and Canada. Participants included Edward L. Bortz of Philadelphia; Johan Bjorksten, the Bjorksten Research Foundation, Madison, Wis.; William B. Lountz, Washington University; Gordon Aldridge, Michigan State University; and L. E. Burney, assistant surgeon general.

■ The National Council of Phi Tau Sigma, the honor society for food science, has granted a charter for a chapter at the University of Georgia in Athens. Other chapters are at the University of Massachusetts, Massachusetts Institute of Technology, and Rutgers University.

■ The third Western Area Development Conference will be held at Phoenix, Ariz., 31 Oct.–1 Nov., with "Resources for industrial expansion" as its theme. Arranged by Stanford Research Institute and cosponsored by the Confederacion de Camaras Industriales de los Estados Unidos Mexicanos, the conference is expected to attract more than 500 business and industrial executives from the United States, Mexico, and Canada.

Executive secretary of the conference is Carleton Green, manager of the Mountain States Office of Stanford Research Institute at Phoenix.

■ The German engineering societies, VDI and VDE, are sponsoring an automatic control conference to be held at the University of Heidelberg 25–29 Sept. This will be an international meeting with the Soviet Union actively participating. There will be more than 80 papers by automatic control experts from the United States, Japan, Yugoslavia, and several other countries.

Society Elections

■ National Association of Science Writers: pres., Roland H. Berg, *Look Magazine*; sec., John Troan, *Pittsburgh Press*. Representative to the AAAS Council is Herbert B. Nichols.

■ Phi Tau Sigma, the honor society for food science: pres., Carl S. Pederson, Cornell University; v. pres., Emil N. Mrak, University of California; sec.-treas., Edward E. Anderson, University of Massachusetts; exec.-sec., F. J. Francis, University of Massachusetts.

■ American Association of Neuropathologists: pres., Ben Lichtenstein, Chicago, Ill.; v. pres., K. Scharenberg, Ann Arbor, Mich.; sec.-treas., Leon Roizin, New York, N.Y.

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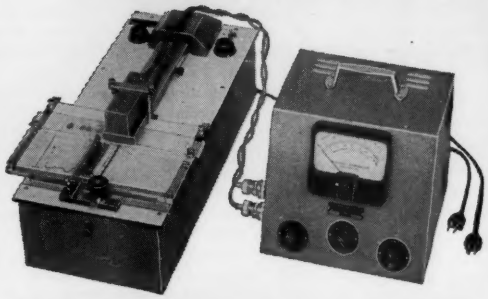

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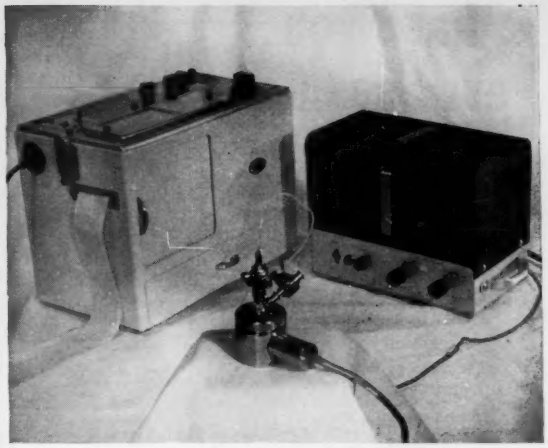

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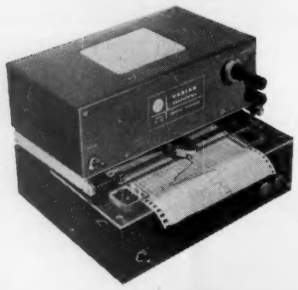

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■ American Neurological Association: pres., H. Houston Merritt; pres.-elect, Israel S. Wechsler; 1st v. pres., Richard B. Richter; 2nd v. pres., Augustus Rose; sec.-treas., Charles Rupp.

■ American Board of Oral Medicine: chairman, Samuel C. Miller, New York University College of Dentistry; sec., Lester W. Burket, University of Pennsylvania School of Dentistry; treas., Harold R. Gelhaar, Upper Montclair, N.J.

■ American Home Economics Association: pres., Beulah V. Gillaspie, Purdue University; sec., Nellie Buckey, Department of Education, Baltimore, Md.

Forthcoming Events

August

27–31. Colloquium on Statistical Mechanics of Transport Processes, IUPAP, Brussels, Belgium. (I. Prigogine, 40 Avenue F. D. Roosevelt, Brussels.)

September

3–10. History of Science, 8th intern. cong., and International Union for the History of Science, 4th general assembly, Florence and Milan, Italy. (Vasco Ronchi, Instituto Nazionale di Ottica, via San Leonardo 79, Florence, Italy.)

4–5. Meteoritical Soc., 19th meeting, Bloomington, Ind. (C. W. Beck, Dept. of Geology, Indiana Univ., Bloomington.)

4–6. International Assoc. of Milk and Food Sanitarians, annual, Seattle, Wash. (H. L. Thomasson, IAMFS, Box 437, Shelbyville, Ind.)

4–7. American Physiological Soc., Rochester, N.Y. (M. O. Lee, APS, 9650 Wisconsin Ave., Washington 14.)

4–9. American Ornithologists' Union, annual, Denver, Colo. (H. F. Mayfield, 2557 Portsmouth Ave., Toledo 13, Ohio.)

4–11. International Geological Cong., 20th, Mexico, D.F. (Congreso Geológico Internacional, Calle Balderas 36, Despacho 302-A, Mexico, D.F.)

4–11. International Paleontological Union, Mexico, D.F. (H. E. Vokes, Johns Hopkins Univ., Baltimore 18, Md.)

5–7. Atmospheric Optics Symposium, Petersborough, N.H. (F. D. Smith, Boston Univ. Physical Research Labs., 700 Commonwealth Ave., Boston 15, Mass.)

5–7. Cryogenic Engineering Conf., Boulder, Colo. (P. L. Barrick, National Bureau of Standards Cryogenic Engineering Laboratory, Boulder.

5–7. Wyoming Geological Field Conf., 11th annual, Moran, Wyo. (K. W. Frielinghausen, Box 1571, Casper, Wyo.)

5–13. International Cong. of Applied Mechanics, 9th, Brussels, Belgium. (H. L. Dryden, Director, National Advisory Committee for Aeronautics, Washington 25.)

6–8. American Political Science Assoc., annual, Washington, D.C. (E. M. Kirkpatrick, APSA, 1726 Massachusetts Ave., NW, Washington 6.)

6–8. Phi Sigma Soc., Ann Arbor, Mich. (K. F. Lagler, Dept. of Fisheries, School of Natural Resources, Univ. of Michigan, Ann Arbor.)

6–12. International Genetics Symposium, Tokyo and Kyoto, Japan. (Secretary, IGS 1956 (Science Council of Japan, Ueno Park, Tokyo.)

7–9. American Sociological Soc., annual, Detroit, Mich. (Mrs. M. W. Riley, ASS, New York Univ., Washington Square, New York 3.)

7–10. American Statistical Assoc., annual, Detroit, Mich. (D. C. Riley, ASA, 1757 K St., NW, Washington 6.)

7–10. Biometric Soc., ENAR, Detroit, Mich. (A. M. Dutton, Univ. of Rochester, Box 287, Station 3, Rochester 20, N.Y.)

7–10. Econometric Soc., Detroit, Mich. (R. Ruggles, Dept. of Economics, Yale Univ., New Haven, Conn.)

9–12. American Inst. of Chemical Engineers, Pittsburgh, Pa. (F. J. Van Antwerpen, AIChE, 25 W. 45 St., New York 36.)

9–13. International College of Surgeons, 21st annual, Chicago, Ill. (K. A. Meyer, 1516 Lake Shore Drive, Chicago 10.)

9–14. International Cong. of Clinical Chemistry, New York, N.Y. (J. G. Reinhold, 711 Maloney Bldg., Univ. of Pennsylvania, Philadelphia 4.)

9–16. Cong. on Analytical Chemistry, Lisbon, Portugal. (P. A. Laurent, Instituto Superior Tecnico, Av. Rovisco Pais, Lisbon.)

10–12. American Soc. of Mechanical Engineers, fall, Denver, Colo. (C. E. Davies, ASME, 29 W. 39 St., New York 18.)

10–12. Electron Microscope Soc. of America, annual, Madison, Wis. (Miss J. R. Cooper, Nela Park 130, Cleveland 12, Ohio.)

10–14. Electron Transport in Metals and Solids, colloq., Intern. Union of Pure and Applied Physics, Ottawa, Canada. (K. C. MacDonald, National Research Council, Ottawa.)

10–14. European Soc. of Cardiology, 2nd cong., Stockholm, Sweden. (K. E. Grewin, Sodersjukhuset, Stockholm.)

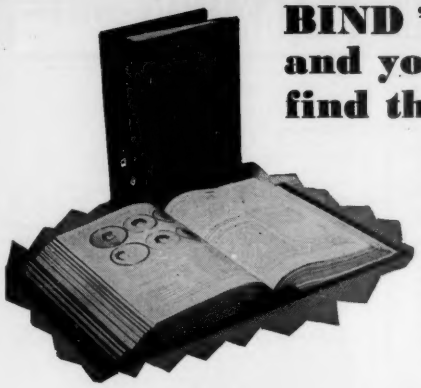
10–14. Immunomicrobiological Standardization Symposium, 2nd, Rome, Italy. (G. Penso, Instituto Superiore di Sanita, Viale Regina Elena, 299, Rome.)

10–14. International Conf. on Fatigue of Metals, London, England. (Secretary, Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1.)

10–14. International Cong. on Catalysis, Philadelphia, Pa. (H. Heinemann, ICC, c/o Houdry Process Corp., P.O. Box 427, Marcus Hook, Pa.)

10–14. International Cong. of Dietetics, 2nd, Rome, Italy. (American Dietetic Assoc., 620 N. Michigan Ave., Chicago 11, Ill.)

(See issue of 20 July for comprehensive list)



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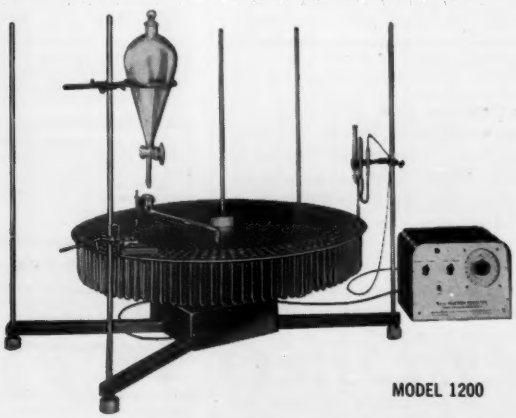

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Program content

1. The two-session general symposium, "Moving Frontiers of Science," arranged by the Committee on AAAS Meetings.
2. The six sessions of the Conference on Scientific and Technical Editorial Problems.
3. Details of the anniversary celebrations of the AAAS-Gordon Research Conferences, Botanical Society of America, Freud *et al.*
4. Programs of the 18 AAAS sections (symposia and contributed papers).
5. Programs of the more than 80 participating societies.
6. The Special Sessions: AAAS, Academy Conference, Conference on Scientific Manpower, National Geographic Society, Phi Beta Kappa, RESA, Sigma Xi.
7. Details of the Hotel Statler—center of the Meeting—and other hotels and session sites.
8. Titles of the latest foreign and domestic scientific films to be shown in the AAAS Science Theatre.
9. Exhibitors in the 195[illegible] Annual Exposition of Science and Industry and descriptions of their exhibits.

Directory content

1. AAAS officers, staff, committees for 1956.
2. Complete roll of AAAS presidents and their fields.
3. The more than 265 affiliated organizations.
4. Historical sketch and organization of the Association; the 1955 revised Constitution and Bylaws.
5. Publications of the Association.
6. AAAS Awards and Grants—including all past winners.
7. Membership figures by sections.
8. Section committees (Council members) in detail.
9. Local committees.
10. Future Meetings of the AAAS through 1962.
11. New and current activities of the AAAS.

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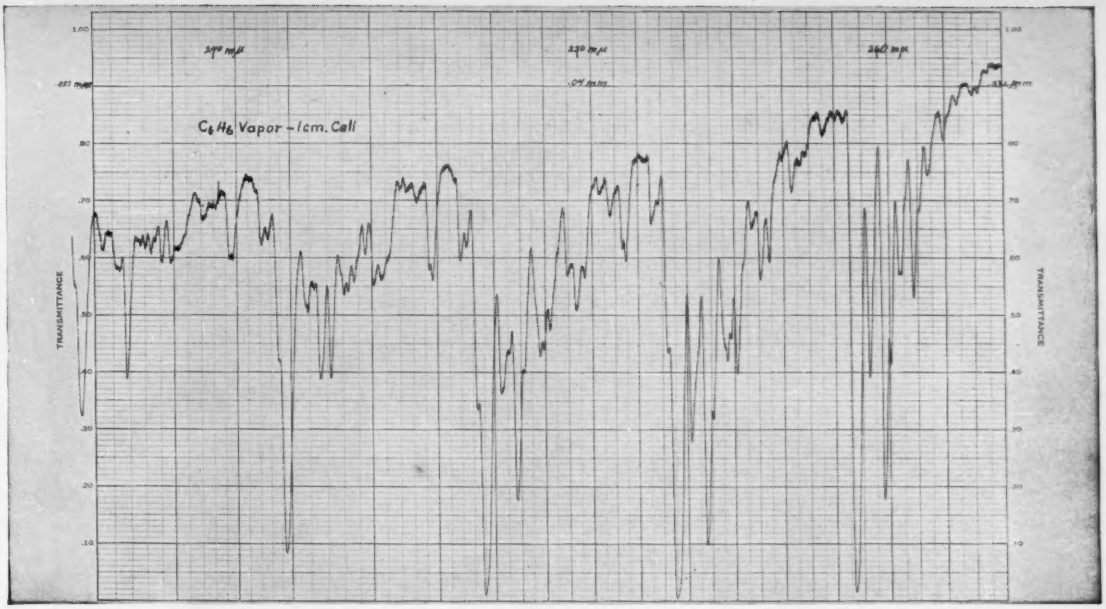

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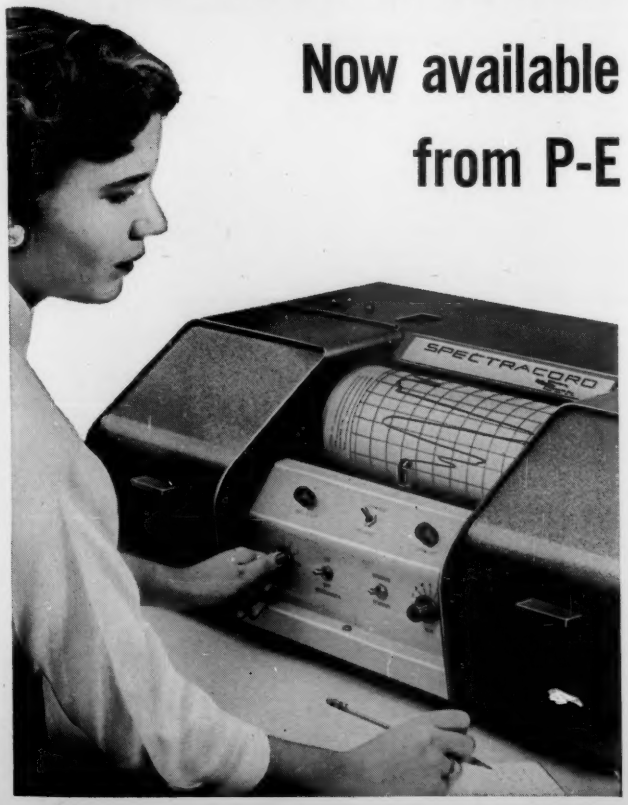

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▶ For quick, convenient and safe mounting and dismantling of apparatus with spherical interchangeable ground glass joints

Fig. 1. Showing appearance of Sizes 12 and 18. Joint held securely by spring.

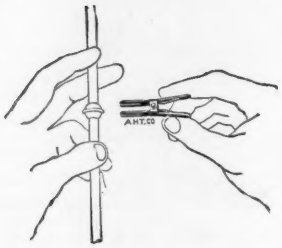

Fig. 2. Showing method of attaching to joint. Parts held securely by spring upon release of finger pressure.

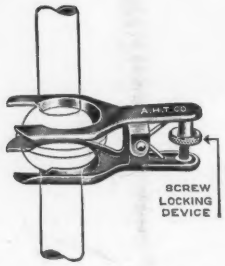

Fig. 3. Showing appearance of Sizes 28 to 75, incl., with locking device screwed into position.

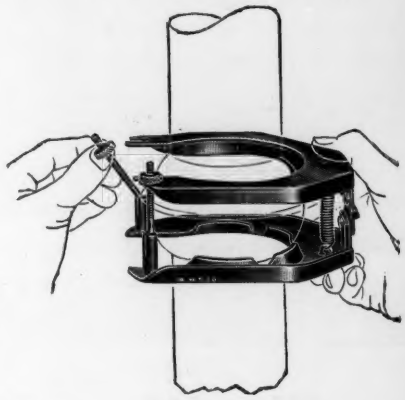

Fig. 4. Showing appearance of Size 102 and method of fastening in position.

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Sizes 28 to 75, inclusive, are provided with a screw locking device—as shown in Fig. 3—in addition to the spiral spring. Size 102 has flat hinge and spiral spring between the upper and lower jaws which permit adjustment of the clamp over the joint with one hand. Two slotted posts, each fitted with hinged screw and knurled head nut, are provided at the mouth of the forked jaws to lock the clamp securely in position.

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